OMNI

DECEMBER 1980 $2.00

SUPERGENES: DECODING THE SECRETS OF IMMORTALITY

MEGAWAR: THINK-TANKING THE UNTHINKABLE

THE TEN BEST GAMES OF THE YEAR

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DECEMBER 1980

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The cover art for this issue is by Kansas-bred Michael Parks. Trained in lithography at the University of Kansas, the artist soon shifted to "free painting" while traveling extensively throughout Europe and Asia. Parks currently paints in his home in southern Spain.

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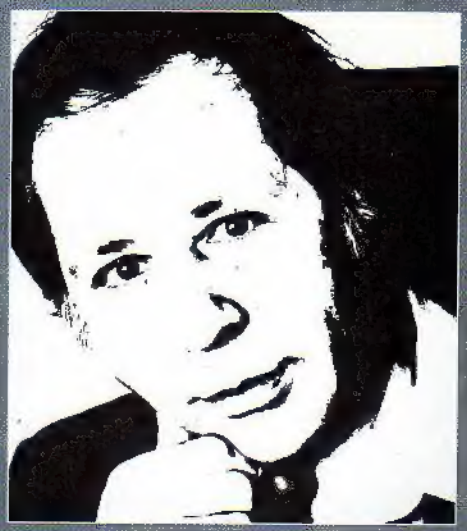

FIRST WORD

By Ben Bova

"The futurists of today also look at the current trends and foresee future disasters."

Christmas and the New Year. Hanukkah. The ancient Roman celebration of Saturnalia. Almost every culture has its midwinter festival, a holiday inspired by the return of the sun.

Long eons ago, in prehistoric times, someone must have noticed that, as the weather grew colder, the days seemed to grow shorter. And shorter. There must have been at least one primitive "futurist" who drew this trend out to its ultimate, chilling conclusion: If this keeps on, the sun will disappear forever, and we will all freeze to death in eternal darkness.

Imagine how glad that futurist's clients must have been when they realized—right around this time of the year—that the days weren't getting any shorter. In fact, they were actually lengthening. Imperceptibly, almost, but lengthening. The sun is coming back! Let's have a celebration!

The futurists of today also look at the world around them and, by observing current trends, foresee future disasters. If the world's population continues to grow, if the earth's resources continue to diminish, if pollution increases and productivity declines . . . gloom unrelieved.

But two researchers at MIT's Sloan School of Management have handed us a lovely Christmas present: a theory of economics that says, in essence, that it is always darkest just before the dawn.

A paper entitled "A Long-Wave Hypothesis of Innovation," by Alan K. Graham and Peter M. Senge, furnishes a tiny ray of light in the midst of all the darkness that most of the futurists are constantly proclaiming.

Their theory says basically that world-wide economic development moves in long-wave cycles of about 50 years' duration. We are nearing the bottom of a downswing, similar to the bottoming out that was reached in the Depression of the 1930s, some (you guessed it) 50 years ago.

Western economies were pretty flat on their backs during the Thirties Depression. Only the advent of World War II got things moving again, according to common economic wisdom. But during that upsurge of economic activity (and brutal warfare) a great spurt of innovative technologies hit the world's marketplaces: electronics, jet aircraft, antibiotics, plastics, rocketry, nuclear power—all these new industries were created in the quarter-century-long upswing from the bottom of the Depression.

Graham and Senge cite the fact that productivity per man-hour in the United States increased by an average of 3.2 percent per year from 1947 to 1966. But it slowed to 2.1 percent from 1966 to 1973, went down to 0.8 percent during 1973–1979, and is now actually negative. Our productivity is decreasing.

Obviously we are on the downhill slide of the long-wave cycle. Decreasing productivity is merely one part of the picture. Unemployment, inflation, loss of international prestige and power, lack of national self-confidence—all these are symptoms of the underlying illness in our economic system.

So is a lack of innovative technologies, for among the victims of this downhill slide is innovation itself. Not that scientists are not discovering new ideas, uncovering new knowledge. Industry is not using this knowledge, these ideas, to create new businesses. Despite the fact that both government and industry loudly proclaim they are seeking technological innovations, R&D budgets are on the decline, and fewer truly new ideas are breaking through from the laboratory to the marketplace.

Graham and Senge claim that this is a natural phenomenon during a long-wave downslide, as natural as the shortening of days toward year's end. Business either is unreceptive to innovations or lacks the new capital necessary to implement them.

But even in the midst of this darkness there is hope. The sun will not disappear forever. Eventually the business community accumulates enough capital to start a new upswing.

It is precisely at this moment in the long-wave cycle that innovative technologies are most welcome. And if we look around us carefully, we may observe precisely that dramatic moment in the 50-year-long economic cycle.

For, although our economy is sagging and productivity has gone negative, several key innovative technologies are showing signs of burgeoning into new industries that will be the mainstays of a new economic upsurge.

The microchip revolution, for example, is building an enormous new industry on the shoulders of older electronics businesses. Microprocessors and home computers are quite a different order of gadgets from the radios and television sets of the earlier economic upswing.

The robot revolution is beginning, as well, and this bids fair to make statistics about productivity in terms of *man*-hours quite meaningless.

Biotechnology is another industry in the making that requires relatively modest capital but that offers huge returns in profits and new human capabilities.

And the new space program, exemplified by the shuttle and by dreams of space industrialization, will be as different from the space race of the 1960s as the Battle of Midway was from a nineteenth-century Thames Regatta.

All around us, the glimmerings of new industries, innovations in the marketplace, show that the MIT researchers may well be correct. We may not be entering merely a new year, but a new upsurge in industry, commerce, and well-being.

The sunshine is returning. Rejoice. ∞

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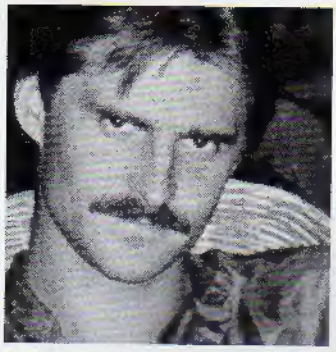

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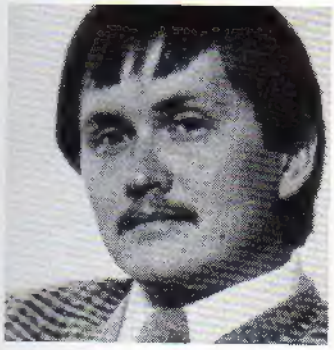

CARD

Ten years after U.S. astronauts touched down on the moon, the U.N. General Assembly passed the Moon Treaty. It is one of the most controversial and far-reaching documents ever written. By stipulating that the high frontier be part of some universal, socialist pie, the treaty strikes at the very core of our incentive to industrialize space. But Congress hasn't ratified it yet. Since *Omni* first raised its voice in opposition to the treaty back in November 1979, other civilian space interests have joined in the fight to waylay the document on Capitol Hill. The treaty won't be in limbo forever. More attention must be directed to the significance of the document, the guile of its architects, and the folly in our willingness to coddle other countries at the expense of our own interests. The scope of this document is important enough that *Ben Bova*, *Omni*'s executive editor, undertook a meticulous evaluation of the treaty's startling implications. If you care about our future in space, read "Moonstruck!" (page 92).

Gerontologists predict, "Physical immortality may not only be possible; it may be relatively simple." This month *Omni* goes through the electron microscope and enters the macromolecular world of "Supergene" (page 80), the enigmatic genetic center that may control aging. Editor and author *Kathleen Stein* visited the laboratories and research centers where scientists track the complex biochemical processes that may someday enable us to live a long, long time. Her report details how the secrets of life extension at this very moment are being painstakingly decoded. Originally trained in Homeric Greek and modern French literature, Stein finds scientific journalism to be "right on the front lines of the imagination." Having written about life extension for several years, she says her only regret is "that it is not possible in one article to discuss all the aspects of gerontology research that contribute significantly to our current understanding of aging and longevity."

What goes on in the Dr. Strangelove world of military think tanks? Do mild-mannered scholarly types sit around planning more efficient means of waging World War III? *Paul J. Nahin* has been on the staffs of both the Institute for Defense Analysis and the Center for Naval Analyses, two major military think tanks. In "For Your Eyes Only" (page 48) he gives *Omni* readers quite a different picture, based on his own experiences. "Not a hell of a lot of think-tank reports have an immediate effect. Most get filed. And most of these are forgotten." Nahin once researched a project called Identification of Air Targets. Unhappy with the resulting report, he published his own views in the *Air University Review*, "to get my piece into the public domain and read by the right people." Instead of alienating the think-tank establishment with his dissenting report, Nahin found himself hired as a consultant. A professor of electrical and computer engineering at the University of New Hampshire, Nahin also finds time to write fiction for *Omni*.

Also highlighting this issue is one of *Omni*'s frequent and most popular contributors, *Orson Scott Card*. Since winning the 1978 John W. Campbell Award for the best new science-fiction author, Card has written many fine works, including two novels, *Hot Sleep* (1979) and *A Planet Called Treason* (1979). His short stories appear in *Analog*, *Fantasy and Science Fiction*, and *Destinies*. An anthology of Card's imaginative work, *Unaccompanied Sonata and Other Short Stories*, will be published by Dial Press in February 1981. Card provides an unusual variation on the post-holocaust theme in "Saint Amy's Tale" (page 88).

Visionary illustrator *John Berkey*'s flair for the dramatic is evident in the sleek, multileveled space structures that characterize his art. Sample Berkey's colorful and imaginative style in "Light Voyager" (page 96), a gallery of his most accomplished work.

Omni is pleased to announce the Grand Prize Winner of our Photo Contest, Canadian *Ints Plampe*. A criminologist, Plampe really loves microphotography. "After looking through my camera lens, I view the world with magnified sensitivity." Plampe's prizewinning photograph is the subject of our December *Phenomena* (page 150). The talented runners-up in this year's contest will be featured in a pictorial in our January issue. ∞

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DECEMBER

LETTERS

COMMUNICATIONS

Cosmic Compassion

What a forcefully thought-provoking combination in one issue—John Pfeiffer ["Countdown to Habitat One"], David Rorvik ["Predestinations"], Ray Bradbury ["The God in Science Fiction"], and Cyril Ponnamperuma [Interview]! I savored every bit of the October *Omni*.

Although we are led inexorably, so it seems, toward an understanding of ourselves and a sense of "cosmic compassion," I have my doubts on at least one point.

In "Predestinations," Sir Francis Crick is quoted as asserting, "No newborn infant should be declared human until it has passed certain tests regarding its genetic endowment. . . . If it fails these tests, it forfeits the right to live."

Is this the future of genetic engineering?

Charles W. Atterberg
Hanover Park, Ill.

Four-legged Drive

Dean Ing's article about the future of personal transportation ["Accelerations," September 1980] fails to mention a presently available all-terrain vehicle.

This vehicle provides control of the suspension and the ability to avoid obstacles (even if the operator is drunk), without requiring the use of dipole antennae or signaling devices.

This vehicle is often referred to by the generic term *horse*.

Jay Holovacs
Manville, N.J.

Interstellar Mail

After reading the article in Continuum regarding the Planetary Society [September 1980], I was amused to see that the society had arranged for a post office box number that is the product of two prime numbers (59 and 61).

Even more amusing is the society's zip code, which is the product of three prime numbers: 17, 23, and 233.

Do you imagine the Postal Service is also looking into the possibility of interstellar radio messages?

Bob Porter
Columbus, Ga.

Favorite Curio Shop

It may have taken you a month to put together September's issue, but I devoured it in two evenings. One of my favorite stories was "The Curio Shop," by William Kotzwinkle.

It was one of those rare stories that could be read twice and that would have a different meaning each time. Let's see more of Kotzwinkle's work.

Mark Steinberg
Chicago, Ill.

Wrong Numbers

Your item on the discovery of the positron [People, September 1980] correctly reports that Caltech was slow in promoting Carl Anderson after he received the Nobel Prize. But the numbers you quoted are in error. You say, "Anderson won the Nobel Prize for his discovery of the positron at the age of forty-two, but he had to wait seven more years before receiving full professor status." The correct dates are: birth, 1905; discovery, 1932; prize, 1936; and professorship, 1939.

Luis W. Alvarez
University of California
Berkeley, Calif.

The Common Cold

In regard to Stuart Diamond's article "Cold Cures" [Continuum, September 1980], one has a feeling neither cure is better than previous treatments. The first cure, blowing warm, moist air up the nose, requires a half hour's treatment. Few people have the patience to spend that much time with nozzles up their nose. The other cure, crying, has side effects similar to the symptoms of the disease: red eyes, a runny or stuffy nose, and often a headache.

These treatments work for some people, but a large part of the cure comes with a belief in the efficacy of whatever treatment is being used. Perhaps science will someday find a miracle cure that will work for everyone. Until then, the best cure for that most common of human ailments is time.

Renee Church
Rochester, Minn.

DIALOGUE

FORUM

In which the readers, editors, and correspondents discuss topics arising out of Omni and theories and speculation of general interest are brought forth. The views published are not necessarily those of the editors. Letters for publication should be mailed to Omni Forum, Omni Magazine, 909 Third Avenue, New York, NY 10022.

Take a Hike

Roger Rapoport's article ["Unbreakable Code," September 1980] was a very informative piece. However, a little more information about Joseph Meyer, the man mentioned as having threatened code researchers, may interest *Omni* readers.

Meyer wrote an unattributed paper advocating the implantation of electronic tracer devices on people with criminal backgrounds. This paper was published in the journal of the Institute of Electrical and Electronic Engineers (IEEE).

Meyer's professional affiliation was given as being with the "Department of Defense," and his address was his private home in Maryland. Clearly, Meyer had the blessings of his superiors to threaten people, if he did so as a private citizen.

Over the years I've followed with interest Meyer's career as a National Security Agency *agent provocateur*. Threatening IEEE members to cease research on codes (or else), as he did a couple of years ago, caused quite a stir. At that time I wrote a letter criticizing the pussyfooting of the IEEE leadership and their failure to tell Meyer to take a hike to hell.

After reading the ridiculous comments by NSA's director, Vice Admiral Bobbie Ray Inman, I'd like to offer him the same suggestion. The Russians will use the unbreakable codes whether it bothers Inman or not. The only people being denied their use are Americans. Inman, Meyer, and the NSA seem to have got confused on just who is the adversary.

Dr. Paul J. Nahin
Durham, N.H.

Monopoly on the High Frontier

Having read the article "Universe Red," by Craig Covault, in *Omni*'s August 1980 issue, I recommend a book by Peter N. James, a former manager of the Foreign Technology Program at Pratt & Whitney Aircraft. The book, *Soviet Conquest from Space*, gives a detailed description of the Soviet Union's shuttle program.

According to Covault, "we have only recently discovered" the program, which was begun in 1966! Covault further states that the Soviet vehicle has nowhere near the capacity of ours, but in fact the Soviet shuttle will be capable of lifting into orbit a payload anywhere from 4,500 to 16,000 kilograms heavier than our own can carry.

Even more distressing is the fact that the development of an American orbit-to-orbit shuttle, which could reach the higher geosynchronous orbits, has been deferred because of budgetary problems. Because of fuel limitations, our shuttle will be restricted to lower-orbit operations. The Russians' orbit-to-orbit shuttle program will place them within striking range of our high-orbit satellites.

With the massive Soviet military buildup of the past 20 years, the USSR's space program has received a larger and larger portion of the Soviet budget; ours, only curtailments. In view of this intensive Soviet research-and-development effort, I wonder how much longer the United States will have access to the high frontier.

David Rutt
Tucson, Ariz.

Craig Covault replies: *I stand by my statements as printed. While it may be true that the USSR had a shuttle craft planned in 1966, there was no solid evidence of this until 1978. As for the payload, my information is the best available from the professional analysts involved. There has always been speculation about what the Russians were up to, and a reusable space vehicle was a logical step in the early 1970s. What this question comes down to, really, is whether you prefer the guesswork of amateur analysts or verifiable facts, such as satellite photos. I prefer the facts.*

After reading Craig Covault's article on Soviet space research, I'd like to supply a bit more information that may interest *Omni* readers. The British Interplanetary Society's magazine, *Spaceflight*, has published occasional items on the *Kosmolyot* shuttle, culled from official announcements broadcast by Moscow Radio.

The Soviet delta-winged orbiter is larger than the U.S. shuttle, though probably not by much. The three main engines are positioned at the rear, and the overall length of the vehicle is about 61 meters. This figure presumably includes the first stage, also designed to be recoverable. The overall diameter, "including fuel containers" (expendable strap-ons, perhaps?), is put at about eight meters.

It's also worth noting that *Spaceflight* reproduced some photographs of Chinese astronauts in training. One shows "training in a space simulator," which, judging from the seat positions and instrument layout, must be a winged reentry vehicle.

I would urge anyone with an interest in the Soviet space effort to become a regular reader of *Spaceflight*, because its coverage is among the most comprehensive in the Western world. Even Radio Moscow has recommended the magazine to its overseas listeners. Of course, there are just as many articles concerning the American, European, and other major programs. For further details write to Executive Secretary, The British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ, England. In the United Kingdom, enclose a large envelope, stamped and addressed. Elsewhere, send a self-addressed envelope with an International Reply Coupon.

Alex Stewart
Colchester, Essex
England

Delightful but Disturbing

Dean Ing's article "Accelerations" [September 1980] featured delightful photography but a disturbing text. To mention one annoying point, the article seemed to advance the notion that in the not-too-distant future, common passenger

cars will be as exciting as those shown. This transformation of the passenger vehicle would supposedly come about through new aerodynamic designs resulting from fuel-conservation efforts.

This is a complete misreading of automotive design trends. Two of the vehicles depicted, the Pininfarina Modulo and the Vector, are in no way indicative of what mass-produced passenger cars of the future will be like. These exotic sports vehicles (prototypes yet!) represent a highly specialized segment of the automotive market. It is mathematically improper to extrapolate trends for a general body of data from a few unrepresentative cases. The Ford Megastar, though a "passenger" car, is, in actuality, a "concept" (show) car.

The automotive facts of life are: In the speed range that is characteristic of, and given the utility expected of, passenger vehicles, the most significant increase in fuel efficiency is obtained through a reduction in vehicle size (less weight and frontal area). This forces a course toward smaller, especially narrower, vehicles with minimum front/rear overhang. Internal usable volume will become an increasingly larger percentage of total volume. As this trend continues, there will be less and less length available for molding into streamlined curves.

In short, the mass-production car of the foreseeable future will resemble today's "econo-boxes" with additional aerodynamic refinement. Windshields may be more steeply raked, hoods sloped, and airdams, vents, and spoilers may abound, but the general form will have more in common with the General Motors "X" body and the Volkswagen Rabbit than with the Pininfarina Modulo.

B. P. Wiegand
Levittown, N.Y.

Styling will never go out of style. The public will not buy boxes—a fact the Japanese seem to understand quite well. This was brought out in Mr. Ing's story. The vehicles shown were not intended to illustrate future automobiles. Rather, each of the cars displayed one design feature that may indeed find its way into the automobile of the future. —Ed.

Contact

Your reply to the letter about Robert Truax, of Saratoga, California, was excellent [Forum, September 1980]. The fact that a man is even trying such a feat is commendable, let alone that he is doing it through private initiative rather than government sponsorship.

Your contribution to this work is not to be overlooked, for you are responsible for educating the "40 Chicago businessmen" who formed Project Private Enterprise. The only thing you left out is mentioning a way to contact these businessmen so that others may help sponsor this endeavor.

I should greatly appreciate it if you would correct this oversight.

Michael A. Cummings
Georgetown, S.C.

Project Private Enterprise (PPE) keeps moving along. In September it conducted a drop test to test the parachute rocket-return system and learn whether the engine could withstand the punishment of launch, return, impact, and relaunch. The test was successful, and PPE is pressing on with plans for the first unmanned flight on July 4, 1981, the twentieth anniversary of Alan Shepard's Mercury flight. The first manned Truax flight is scheduled for the fall of 1981. PPE is happy to hear from supporters, financial and otherwise. Write to John Feeney, Project Private Enterprise, Suite 102, 4425 Riverside Drive, Burbank, CA 91505. —Ed.

Naturally

I am surprised that a magazine such as yours, which keeps up with new achievements and speculations, has not reported on the science of natural medicines—vitamins and minerals—and their prevention and cure of many ailments.

I was suffering from kidney stones until I read in a health book about magnesium. Magnesium keeps calcium from crystallizing into stones.

I think that when you look for answers to medical questions, you should keep in mind the substances that are available in nature, not just in a pharmacy.

I believe there is a vegetable, mineral, or animal cure for every disease on Earth.

Christy Caton-Garcia
Dittmer, Mo.

In case you missed it, Belinda Dumont's article "Orthohealing" [February 1980] examines the revolution in modern medicine concerning vitamins and minerals, just as you say. —Ed.

Aggressive Leadership Needed

While Arthur Kantrowitz [Interview, July 1980] had some intelligent comments on society's "need for new ways to come to grips with science and technology," he betrayed the same mind-set as so many nuclear enthusiasts, namely, that when the public "understands" nuclear-power technology, it will accept it. He shows the same willingness as other enthusiasts to ignore the issue of financial accountability (or, rather, the lack of it) on the part of nuclear-powered utilities for their own operations.

In the five years since the Nuclear Regulatory Commission was created, the U.S. General Accounting Office has issued some 50 reports on the performance of the commission and of the nuclear industry. GAO is neither "pronuclear" nor "antinuclear." The only thing it promotes is responsible government. The primary function of the GAO is to provide Congress and the public with balanced and objective information on a wide range of government operations. GAO's address is:

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George G. Everts
Emporia, Kan.

Value Received

I have read articles in *Omni* and other publications where the author moans about the space program or some other scientific program receiving such a small percentage of the federal budget. The implication is that these organizations should be in line for handouts from the government, trying to get a larger share than before, and that there is nothing wrong with lobbying for unearned economic rewards. Must such a noble endeavor as science encourage this kind of welfare thinking?

Ideally, the existence of any enterprise, be it scientific or commercial, depends upon its ability to cover investments and maintain profits—to return value for value, so to speak. If there is any value to what scientists discover, invent, or produce, their goods and services can compete on the open market with all the other goods and services offered. Objectively speaking, the individuals who have rightfully earned their money can determine the value of these products just by what they purchase. The organizations whose product is most in demand will be the ones to survive and sustain the process. I cannot understand why science should be held exempt from these fundamental laws of economics.

Carl Rutz
Dallas, Tex.

Advanced research is very expensive. Can you imagine going as a private citizen to your banker to borrow the money to set up a laboratory with an electron microscope? In fact, too many federal and private research grants depend on a demonstration of commercially justified results before the grant is awarded. So you have little progress, with scientists constantly reverifying each other's work, or "name" researchers getting grants on the basis of past research, then sneaking off to do something unapproved to break new ground. Science always has depended and always will depend on patrons—governments, schools, corporations, or individuals—willing to invest in the future by paying for scientists to go up as many blind alleys as they must to find the one breakthrough they seek. —Ed.

DELTA PROJECT

EARTH

By Gordon F. Sander

God created the earth," an eighteenth-century Frenchman remarked after touring the hydraulic wonders of the Netherlands, "but the Dutch made Holland." Without the vast system of dikes and pumping stations the Dutch have raised over the centuries, the Netherlands would be flooded twice a day—something to think about as one's plane touches down at Amsterdam's Schiphol Airport, itself the site of an ancient lake. Now the Dutch are putting the final touches on the masterpiece of macroengineering that protects the homes of 14 million people.

The Netherlands' hydraulic energies, and much of the country's gross national product, are being trained on the quaint southwestern province of Zeeland—the region most vulnerable to the wrathful North Sea. There a mighty engineering task force is engaged in a fantastic project that aims to seal off the gaping mouths of the Rhine, Maas, and Schelde rivers. When completed in 1985, this miracle of engineering—code named Delta—will make the country watertight. Comparable in labor, cost, and imagination to the great Tennessee Valley and Aswan Dam programs, the Delta Project is the largest civil engineering project of our time. It has already been in the works for a generation.

One by one over the last quarter century, six steel caisson dams averaging eight stories in height and 13 kilometers in width have been painstakingly tugged, dropped, and driven into place. Three more giant stopcocks now under construction will soon tame the Schelde, the largest and fiercest of the delta mouths and the last of three to be closed.

As has often been the case in the Netherlands, the Delta Project was prompted by a great catastrophe, one that still gives Dutchmen nightmares. Between the hours of 2 A.M. and 6 A.M. on February 1, 1953, a superstorm combined wind, tide, and wave effects in a way that scientists later calculated was statistically possible only once every 350 years. It created a bilious, cyclone-powered battering ram of water 1,000 kilometers wide. Most of Zeeland was quickly inundated, tearing more than 300 breaches in the coastal sea wall. The storm very nearly caved in the thick dikes up the Rhine that protect the heartland cities of The Hague, Amsterdam, and Rotterdam. When morning broke, more than 1,800 Dutch lay dead, 400,000 frightened persons clung to trees and rooftops, and 120,000 hectares of the country's finest farmland had vanished. The nation resolved: Never again.

To be sure, Dutch engineers had concluded long ago that the old sea dikes around Zeeland would not withstand the severest gales and that it might be better to close off the delta altogether. But the delta arms were far too wide to be diverted. So the Dutch built where no nation had built before: under water averaging 60 meters deep, amidst 30- to 40-knot currents.

One by one, a zigzag of great links in the new sea wall has been forged. After considerable trial and error, two basic methods were perfected to close the rivers. The simultaneous method was first used to stitch the mouth of the Maas shut. Caissons are built in drydock, temporarily are made watertight with wooden sides, and are floated individually to the correct point in the swirling estuary mouth. At a signal, the steel gates within each caisson are simultaneously dropped into the river like one long guillotine, slicing off the current. Thus on a sunny day in 1961 the Veeregat was sealed at one stroke. The gradual method, no less ingenious, uses a cable car to bomb the dam sites with carefully placed concrete blocks.

Field operations are still overseen from the Delta Project command center in The Hague, where computers monitor winds, tides, and waves to be sure the dams adjust to the most extreme of variable conditions. So far the project has cost 4 billion guilders—proportionately more than the race to the moon. Before 1985, another 2 billion guilders will be spent.

Meanwhile, beneath the mists of Zeeland, the spectacle continues and the nation waits to hear that it is finally safe. Millennia hence, historians and archaeologists will still be visiting the Delta Project and marveling at Dutch resolve.

Advances in hydraulic engineering are helping the Dutch reclaim their country from the sea

UNBORN MIRACLE

LIFE

By Dr. Bernard Dixon

Heart surgery *before* birth is the staggering but realistic prospect now being considered by cardiologists in the United Kingdom and the United States. Twenty years ago the very idea of operating on an unborn child's heart might have been dismissed as absurd fantasy. Yet medical experts believe that within the next two decades this kind of prenatal surgery will be saving scores of babies from certain death.

One typical condition threatening the unborn child involves the premature closing of the hole between the two upper chambers of its heart. This orifice, known as the foramen ovale, receives life-giving oxygen directly through the umbilical cord since the lungs are not yet functioning. At birth, however, this hole closes, the umbilical cord is severed, and the baby begins to breathe through its lungs.

Occasionally either the foramen or another bypass, the ductus arteriosus—or both of them—fails to close. The heart becomes handicapped, producing a condition known as the "blue baby" syndrome. Such defects are now routinely corrected by simple postnatal surgery—the so-called hole-in-the-heart operation. But what of the life-threatening state that arises when the foramen closes *before* childbirth? This malfunction could be prevented by creating an artificial hole between the two chambers of the heart.

Innovations involving surgical techniques with animals have given surgeons more confidence in such delicate and hazardous tinkering. It is now 50 years since a courageous young German doctor, Werner Forssmann, inserted a thin tube into a vein in his left arm and directed it up into his heart. Such catheterization is now widely used to investigate cardiac victims. Recently, however, researchers have been successfully employing it to study the hearts of lambs before they are born. Special catheters have been developed, tipped with tiny inflatable balloons, that are capable of creating or widening orifices inside equally tiny blood vessels. A surgeon could conceivably steer such an instrument, by observing it through an x-ray screen, through the circulatory system and into an unborn child's heart. Inflated at precisely the right place, the balloon catheter could thus be used to prevent the foramen from closing too soon.

It was this sort of procedure that Professor Fergus Macartney had in mind when he spoke before the World Congress of Pediatric Cardiology, which was held earlier this year in London. But Professor Macartney, who works at the Hospital for Sick Children, on Great Ormond Street, in London, was also careful to caution his audience that such developments are by no means imminent.

The major hurdle remaining is not that of correcting fetal heart defects but of diagnosing them accurately. This formidable task may depend entirely on the adaptation of a sophisticated tool called echocardiography. A pulse of ultrasound is beamed through the chest. Echoes from the heart's various surfaces are recorded. Analysis of these patterns by a skilled diagnostician reveals irregularities in the functioning of the heart. But the degree of discrimination required to pinpoint the tiny, narrowing hole in an unborn child's heart is beyond the capacity of any machine yet in routine use. Moreover, the need for such highly specialized diagnosis means that prenatal surgery will be confined initially to a few centers where the equipment is available. Costs may be high at first, but will fall as the technique becomes routine.

But the signs are favorable and encouraging. Detection of disease before birth is a blossoming new field in medicine. A journal devoted exclusively to the subject will premiere next month. *Prenatal Diagnosis* will be concerned solely with the identification of abnormalities in the fetus as it matures. These days high technology in medicine is in disfavor. Its opponents argue that there is a simple choice between treatment and prevention. But recent advances are eroding this prejudiced view. Already progress has been made in diagnosing sickness in human fetuses by sampling fetal cells and blood. With similar advances in echocardiography, the surgeon's skills will one day be accomplishing major miracles for the unborn child.

SALYUT REDUX

SPACE

By James Oberg

As the Soviet space station *Salyut 6* completes its third year in orbit 350 kilometers overhead, Soviet space scientists must be nearly ready for their next step, *Salyut 7*. Russian technologists are usually very tight-lipped about their plans, but their record-breaking achievements in space have moved them to make surprising revelations about their next moves.

The accomplishments of *Salyut 6* are impressive enough. Cosmonauts have spent half a year in space without any medical complications. Robot freighters have delivered supplies, equipment, and fuel that by now equal the weight of the original space station. Earth-resources photography, using a sophisticated East German camera array at least as good as *Skylab*'s, has been overwhelmingly aimed at practical uses, not scientific research. Products created by the space station's furnaces are now the purview of manufacturing institutes rather than pure research laboratories. And the cosmonauts have been able to maintain the aging space station by replacing worn-out equipment and by overcoming the inevitable breakdowns with ingenuity and determination. *Salyut 7* is certain to improve on even this record.

The new space station's most distinctive feature will clearly be its modular design. Sergei Grishin, a leading official in Moscow's Mission Control Center, wrote last year that "orbiting stations of future generations will consist of separate, independently launched modules. The main module will offer more comfortable conditions for crews. Others will contain scientific apparatus and technological equipment. Moving into a laboratory that has arrived, cosmonauts will begin special operations without wasting time on transferring equipment. After research is completed, the module may be separated, or it may be replaced by a new one that has arrived from Earth."

Cosmonaut Georgi Grechko has confirmed that the next Soviet space station will have several docking ports. (*Salyut 6* has two; earlier *Salyut*s had only one.) Some will handle manned and unmanned transport ships, while others are designed for specialized laboratory modules that will later be permanently attached to one space station. Late last year *Salyut 6* cosmonauts Vladimir Kovalenok and Aleksandr Ivanchenkov told West German space experts that such a *Salyut* would be launched "soon" and would have five, six, or even more docking ports.

Western space analysts admit that this approach makes very good sense, given the Soviets' abilities and needs. The most logical design would be similar to the *Salyut 6* cylinder, which has a docking berth at each end, but with side hatches strung around the station's waist. Visiting spacecraft could dock laterally, like spokes from the hub of a wheel.

The first module to be semipermanently attached to one of these side hatches may already exist. Konstantin Feoktistov, a leading Soviet spaceship designer who flew in space 16 years ago, has stated that it is a "waste" to discard the spherical "orbital module" of the three-part, seven-ton *Soyuz* manned spacecraft. (The *Soyuz* consists of a command and service module similar to *Apollo* and a unique habitable section attached in front of the cosmonauts' command module.) Instead of burning up in the atmosphere when each *Soyuz* returns to Earth, several of the chambers could be left attached to *Salyut 7*'s side hatches.

The Russians practiced just such a maneuver in March, when the 100-day unmanned shakedown of the "new, improved" *Soyuz* capsule ended. The vehicle, dubbed *Soyuz T* (for "transport"), left its orbital module in space before reentry—the first time any *Soyuz* flight has done so. *Soyuz T* obviously is being groomed to replace the two-man *Soyuz* in time for the *Salyut 7* launch. Some Western analysts believe the new model will carry at least three, and perhaps four, cosmonauts. The third seat will open the way for space expeditions by the Soviet Union's first scientist-cosmonauts, whose specialties are urgently needed on the planned permanent space stations: Geologists, oceanographers, astronomers, biologists, metallurgists, and

Salyut 6 *cosmonauts spent half a year in space;* Salyut 7 *should double that record.*

other scientists may already be in space flight training.

A brief manned test flight of the upgraded ship was made last June, when cosmonauts Malyshev and Aksenov linked their *Soyuz T-2* to the occupied *Salyut 6* for a three-day visit. The cosmonauts wore new, improved space suits and tested the spaceship's new onboard computer. For the first time, Soviet space vehicles could conduct autonomous orbital maneuvers without time-consuming commands from Mission Control in Moscow.

Although there were unconfirmed rumors of control problems on the *Soyuz T-2*'s return to Earth, there is no reason to doubt that the new ship will be ready for orbital taxi service by early next year.

The next step in space assembly after docking 2-ton orbital modules onto a 20-ton *Salyut* core would be to dock two of the *Salyut*s end to end. Soviet officials have also forecast that maneuver, but observers are not sure it will be in *Salyut 7*'s repertoire. Very heavy space stations could be assembled in this fashion.

The key problem of juggling the parts has led Soviet experts to envision yet another spacecraft: a "space tug" to round up the separate pieces and push them together. A Soviet news item in 1978 described it: "In this case, only one block, either manned or automatic, is provided with an engine and control system, and it assembles the station in orbit. Another advantage is that, apart from assembly work, the tugboat will be able to perform several other operations. It will undock the specialized blocks of the station and take them to other orbits, bring individual spacecraft to space-based shops for routine checkups and repairs, and launch interplanetary probes. To all appearances the building of interorbital tugboats is not far off, and they are already needed."

However *Salyut 7* is eventually assembled, there is no secret about how long it will be inhabited. "We are very close," cosmonaut commander and three-time space veteran General Vladimir Shatalov wrote in October 1979, "to the constant operation of orbital stations—to around-the-clock and year-round work of cosmonauts aboard them, replacement of crews directly aboard the stations, and regular delivery of the materials into orbit."

Valentin Glushko and other Soviet officials believe that the normal tour of duty will be about a year. Chief Soviet space doctor Oleg Gazenko confirmed in April that year-long flights can be expected in "the immediate future."

Activities aboard *Salyut 7*, which is bound to be remembered as mankind's first permanent space outpost, will extend work already begun. Spaceborne photo surveys and mapping will be pursued as a boost to the Soviet economy. So will the growing ability to manufacture in orbit high-efficiency semiconductor chips, high-purity drugs and other biological preparations, and high-quality optical glass and photosensors. Basic scientific work in astronomy, biology, meteorology, and physics will also be expanded.

Perhaps most important, an increasing, very high fraction of the air, food, and water needed by the crew will be recycled from waste products. The Russians are steadily moving toward the kind of "closed-loop" life support system essential for interplanetary flight.

Last but surely not least, in Russian eyes, we are likely to see more political stunts involving "guest cosmonauts" from the Communist bloc and useful Third World countries. On tap will be cosmic courtesy calls by one cosmonaut each from Mongolia, Romania, France, and possibly Sweden, Afghanistan, Ethiopia, Kampuchea, South Yemen, and the Palestine Liberation Organization. Another of these "guests," who ride in extra seats on the "mail runs" flown by Soviet command pilots, will probably be the second woman in space.

There has been some speculation about the political significance of the order in which guest cosmonauts have been tapped for orbit. It was scotched recently when Maarten Houtman, a Dutchman pointed out the actual pattern. The guests are going up in Cyrillic alphabetical order. So far the sequence has been (in Russian) Bolgariya, Vengriya (Hungary), Viet Nam, and Kuba. This leaves Mongolia and Rumyniya (Romania) to go up next year.

A minority of people watching Soviet space activity believe the next *Salyut* will be merely a successor to the *Salyut 3* and *Salyut 5* military reconnaissance missions of 1974 through 1977. To improve ground observations, a new spy in the sky would probably use a much more inclined orbit than earlier manned Soviet spacecraft did. This would vastly increase the territory over which the cosmonauts would fly but would require the development of more powerful upper stages for Soviet launch boosters. This type of spacecraft would be crewed for up to 90 days at a stretch and would operate by remote control between visits, automatically sending back film pods every few weeks. In this case most of the technological advances forecast for *Salyut 7* would be put off until *Salyut 8* is launched in 1981 or 1982.

Salyut 7, for all its advanced design and abilities, is nowhere near the ultimate in planned Soviet space stations. Boris Petrov, a leading administrator in the Soviet equivalent of NASA (who died in September), wrote recently that "scientists are already designing larger stations, for a crew of 12 to 20, with a life span of up to ten years, which would replace the present small stations. This will happen as soon as it is clear that the present stations have exhausted all of their possibilities."

One report from a Soviet news agency predicts that this stage could be reached in the late 1980s. The Novosti reporter added: "Soviet scientists are already looking forward to the Nineties, when there will be space stations with a life of well over ten years and with a crew of up to 120. These in fact would be real space factories and research institutes."

Western observers are virtually unanimous in believing that these statements are more than mere idle boasts. Similarly specific descriptions preceded the *Salyut 6* mission, and Soviet space experts are quite visibly engaged in all the "homework" required to fulfill their new predictions. Kremlin space doctrine is explicit: "We believe that permanent, inhabited space stations, with interchangeable crews, will be mankind's main road into the Universe."

The Russians intend to travel that road and *Salyut 7* will soon carry them much farther along it. So far they are walking that road alone. ∞

Space manufacturing studies planned for shuttle flights have already been carried out on Salyut 6

MIND

By Don Wa

They are people who fo owed the American Dream They worked hard bought the r own homes, and raised fam lies For years they be- eved everything was f ne Then, in 1977, all they had worked for was snatched from their grasp

Between 1942 and 1952 it was revea ed, some 22 000 tons of chemical wastes capab e of caus ng cancer, birth defects and a grim assortment of other l s had been buried in a trench by a company now ca ed the Hooker Chemical and Plastics Corporation Around that dump site the city of Niagara Falls had bu t a neighborhood Now the people who ved n that neighborhood Love Cana , discovered that they were l ving atop a seeping d saster

Love Cana s no traditional disaster On a flood plain people expect the water to reach dangerous levels. On a barrier sland n a hurricane zone people get used to rebuilding their homes Even the survivors of the Mount St He ens eruptions, once all the ash has cleared w ll start over What occurred at Love Canal was not like a fire, not even like a war there was no burn ng and no ex- p os on It simp y festered. And the psychological impact aside from the physical to l—has been devastating

"We re talk ng about an essential source of stabi ity that has become an extreme threat," says Dr Robert Lifton, a Yale psychiatrist who in 1962 ana yzed the psycho og cal consequences of exposure to the Hirosh ma atom c b ast "It s having one's and, one s earth, turn deadly I think t s a deeper trauma than s caused by any other disasters '

With the Environmental Protection Agency cit ng 4 000 to 5,000 potent al Love Cana s n the United States the possib ity that more such h dden disasters w ll come to light looms large The v ct ms of Love Cana are the first sufferers of a syndrome that may become depressing y common in years ahead

"Evacuat on s poss b e in these s tu- at ons ' Dr Lifton says, "but after they've been evacuated, people st ll worry about what they carry n their bones. They are victims of inv sible contamination that can lead to a lifelong sense of identity w th the doomed. Each time they are sick the nc nat on w be to blame Love Cana "

"Whether or not there are any health problems, people are unsure, and that is reason enough to get them out," says M chael Cuddy who administers the Love Canal re ocation program for the state of New York. "The scientific community in general has spoken the truth as it sees it but the residents don't care about statistics They want a guarantee that there s noth ng wrong here, and scientists cannot guarantee that. The scientific answer s always nebulous. '

Such uncertainty can be demoralizing to a man who drives a forklift all day and w shes things cou d be normal again

I've never seen so many men cry," says Lo s Gibbs pres dent of the Love Canal Home Owners Assoc ation "The women fee protect ve toward the kids. The men fee Yes, want to protect my kids, but this house is my blood my sweat, everything ve worked for Some can t handle it and go out with the boys. Are divorce and separat on w despread? You bet "

Chemical disasters linger in victims' minds

The menta pressure is increased by the difficult liv ng circumstances that are concomitant w th forced evacuat on Some 1 000 fam lies were moved away from Love Canal, but on y 237 have been perma- nently relocated The rest are l ving in motels and surp us m l tary barracks prov ded by New York State Those too o d to move w l live out their lives n a ne ghborhood that s now a ghost town

The residents of Love Canal ke Vietnam veterans exposed to Agent Orange and ke the people near Three M le Island—are the test cases of a new era While society comes to grips w th the fact that environmental disasters are basica y of our own making the victims' needs are often overlooked, thereby aggravating the trauma

"We can't understand why we are knocking on doors and begg ng," says Walt Mikula, who didn't pay much attention to Love Canal until diox n was found n the creek next to his home He is one of 36 Love Canal residents reported to have suffered significant chromosome damage and one of 11 persons whose cond tion has been disputed since the report was first released. "It was ke they had emascu lated me, ' M kula says h s vo ce hushed and somber

We're the v ctims, not the cr minals, says Barbara Quimby a so one of the 11 seriously injured persons whose results have been cha lenged ' I feel like I have lost control, ke somebody else is running my fe I have to read the newspapers to see what I am doing today."

Dr Lifton be eves that sc ent sts and government officia s compound the problem by public y denying the severity of the situat on He calls the r attitude of refusa , psych c numbing

At the r sk of creat ng unwarranted alarm over ills that may or may not occur health authorities he says, must ack nowledge the need to make the fu potent a danger known to the peop e nvolved in h dden disasters

The trauma of uncerta nty may be produc ng some of the Love Cana symptoms, but it does not dimin sh the

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THE ARTS

By Norma Varley

The pagan goddess of Ibiza is Tanit, the goddess of chance acquaintance." Martin Watson-Todd offers this observation to explain how the first multimedia album of science fiction, art, and music evolved. The cranky Englishman owns and operates El Mensajero, an art gallery in the village of Santa Eularia on the Spanish island of Ibiza. Under the influence of the goddess, Watson-Todd was fortunate to meet Robert Sheckley, American science fiction writer to whom Ibiza was home for most of the 1970s (now he resides in New York and is gainfully employed as *Omni*'s fiction editor). Brian Eno, the enigmatic composer, philosopher and bellwether of avant garde music, Peter Sinfield, eclectic English rock lyricist and composer; and Leonor Quiles, talented young Argentinean artist.

Watson-Todd conceived the idea of transforming a Sheckley story into an art object complete with music and illustrations. He chose a little-known novelette, "In a Land of Clear Colors." Eno furnished a musical background, Sinfield narrated portions of the story, and Quiles produced 14 pencil drawings depicting key scenes. The final product is a large, handsomely bound book that comes in a white, LP-sized sleeve, with the LP tucked inside the book's back cover. The edition is limited to 1,000, and the price is $100.

"Clear Colors" is an uncharacteristically somber tale, coming as it does from the prime practitioner of sociocomic SF. Following a classic Sheckley introduction—one Earthman (Goldstein), arrives on alien planet (Kaldor IV)—the story unfolds through Goldstein's journal as he lives out his days on Kaldor. The hero is almost, but not quite, assimilated into Kaldorian society, in a process made more difficult by the rapid shifts in societal norms and customs on the planet. Goldstein's journal only indirectly reveals the changes taking place on Kaldor, for he is changing, too, and is only marginally concerned with "the steady attrition of the humanity." The Earthman's confrontation with the fact of his alienness is haunting.

After Watson-Todd commissioned Quiles to illustrate "In a Land of Clear Colors," which she did through superb erotic fantasies, Tanit went to work in earnest. Eno arrived on Ibiza and chanced to enter Sandy's Bar in Santa Eularia where he met Sheckley.

"We shared a mutual interest in certain things," Sheckley recalls. "For instance, the psychology of invention, how that works. I had been trying to find pre-established schemes to run words and ideas through, as synthesizer players do with themes and sounds. Eno, of course, does that very successfully with sounds, so it was fascinating to see how he works. Unfortunately," he adds, "I don't think there will ever be a synthesizer for writing."

Shortly after that first meeting, Watson-Todd asked Eno to contribute music to the multimedia album in the works. "At that time I had no idea how important Eno was in the world of music," Watson-Todd remembers, with a trace of sheepishness. "I knew that he had worked with David Bowie, but Eno's solo work was completely unfamiliar to me. In retrospect, I am amazed at his good-humored response to my ignorance. Only later did I realize how presumptuous I had been when he told me that during his first two weeks in New York he had been given one hundred eighty-eight tapes by different people wishing to collaborate with him."

Nevertheless, Eno agreed to participate, and Peter Sinfield—another regular at Sandy's Bar—was tapped to provide the voice of Goldstein.

"From that point on," Watson-Todd says with a sigh, "the story took on all the complications of any project involving four artists. It began with the sudden disappearance of Eno, followed rapidly by Sheckley's disappearance. They had agreed to travel together to Majorca—Eno to find a studio where he could make the music, Sheckley to finish a book—before they both traveled to the Far East. The only available studio engineer was, of course, sick. So Eno flew via London to Kuala Lumpur and from there to Bangkok, where it turned out that because of the heat or the enthusiasm or the engineer, all the movable parts were turning at one revolution too few per minute." Watson-

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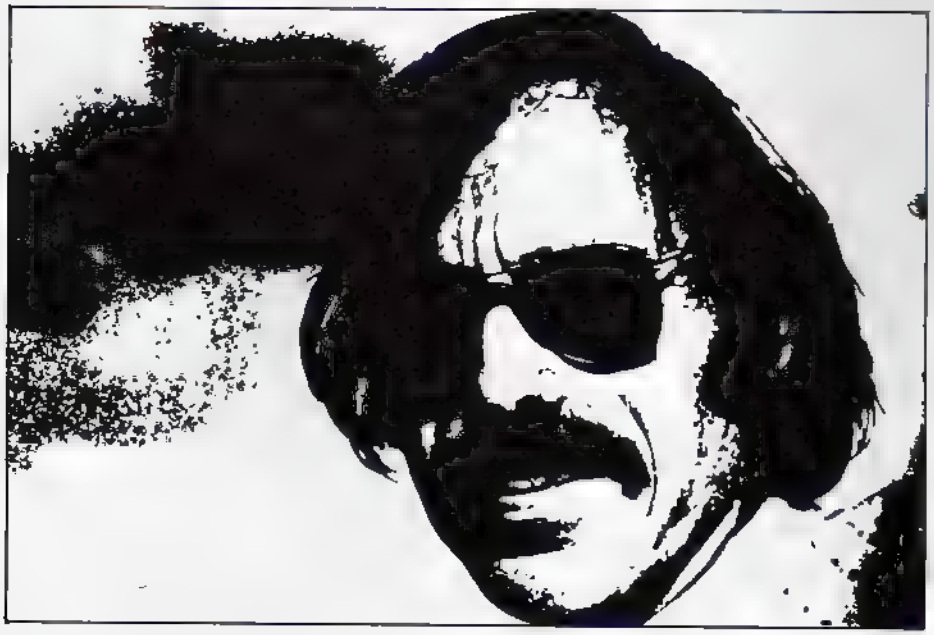


Robert Sheckley's long-playing book: "If I were to do it again, I would do it differently."

FILM

THE ARTS

By Jonathan Rosenbaum

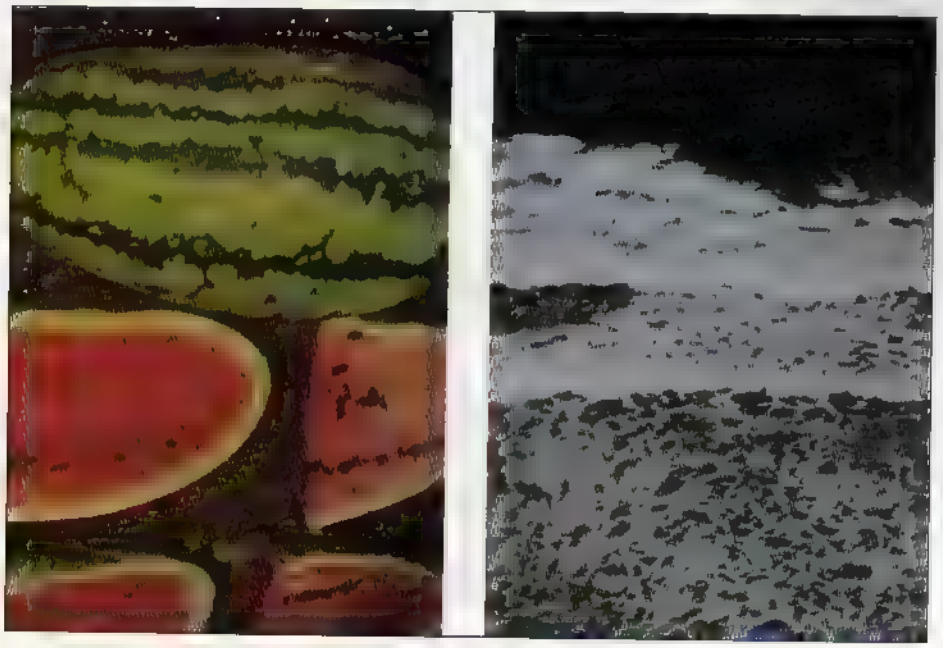
A single thread of 16mm film runs through three side-by-side projectors, all aimed at the same wall. Twenty-two and a half seconds elapse between the time when the first and the second screen images appear and the same amount of time passes between the appearance of the same silent image in the second and third, so that every image can be expected to occur twice in each 45-second cycle.

The title of this 70-minute film piece, made last year, is *Southern California*. Described by its maker, Louis Hock, as a "triptych cinemural," it is also identified by him with precise measurements, like a temporal painting: 30 feet × 7.5 feet × 70 minutes. And temporal painting may not be a farfetched description for what this thirty-two-year-old filmmaker—a man preoccupied with time and motion—is interested in exploring.

One curious consequence of the method of *Southern California* is a novel kind of film rhythm that is at once suspenseful and restful—and oddly evocative of the movement of waves: every time an image ripples across the three projected frames, it also creates a certain analytical distance between the spectator and the cinemural as three temporal stages in the same film sequence are viewed simultaneously.

Why does Hock call it *Southern California*? Because it is mainly an anthology of the sort of things that any tourist to that fabulous region might see: the unrecognizable anonymous skyscrapers of downtown Los Angeles, as seen from the rotating Angel's Flight Bar high atop the Hyatt-Regency Hotel; a multicolored flower farm on a hillside close to San Clemente; a bright array of fruits and vegetables at a high-priced supermarket in La Jolla.

There's even a fair stretch of late-night television, including part of a Rory Calhoun Western and a used-car ad featuring Cal Worthington and His Dog Spot, which is especially familiar to denizens of southern California. Each image, without exception, appears simultaneously in the same "before, during, and after" format. And thanks to the placidity and crispness of Hock's compositions, this format winds up giving all these diverse icons a strange sort of epic grandeur.



Hock's Southern California: visual icons examined in a celluloid space-time continuum

Although he is a native Californian, Hock grew up in Tucson. He attended the school of the Art Institute in Chicago before returning to his home state in 1977, to teach filmmaking in San Diego. He has plenty to say about the place today. "The whole sea of television there has the movies, the aerospace industry, the cars, the health-food industry, the Dodgers, and the grizzly bear," he remarked recently on one of his East Coast visits. "I wanted to suggest in the film how all of California's industry uses us like an advertisement for itself on television."

When he can, Hock prefers to show *Southern California* outdoors. "It's not made for an audience that's subdued—which comes about by putting them in a dark room and having them sit through it," he said earlier this year. "It's made for a casual audience. I intend to show it in large showroom windows on the street, or on a blank wall on the side of a building, or on a billboard or a semitruck—in a *public* place. You can walk into it at any point."

More recently Hock has been able to realize this dream, showing *Southern California* in several outdoor California locations. In a parking lot adjacent to the Santa Monica Pier, a punk rock band called the Armaghetto Ensemble pulled up a flatbed truck and offered free accompaniment. The film was projected on a screen 8 feet high and 30 feet across.

At the Los Angeles Institute for Contemporary Art, the movie was projected into a semitractor trailer, at the San Francisco Art Institute Hock rear projected it onto windows, and on the University of California's San Diego campus, he used the outside of Mandeville Auditorium. Since this successful tour, Hock has been planning a half-hour black-and-white sequel.

And there are other California movies. One, *Pacific Time*, the quirkiest of Hock's films, slows time down to such a crawl that subtitles have to be provided—in Greek, of course—as pundits David Antin and

CONTINUED ON PAGE 146

UFO UPDATE

By Harry Lebelson

One innovation America brings to the UFO question is the use of computers. Allen Hynek, director of the Center for UFO Studies, in Evanston, Illinois, has observed that three times as many UFO sightings undergo computer analysis in America as in Europe. Yet Europe's lack of sophisticated computer analyses is made up for by the thoroughness with which Europeans approach each recorded incident. In Europe a more professional attitude is prevalent in this type of investigation.

One case that reflects the European touch occurred recently in Silkeborg, Denmark. A modern city of 30,000 people, Silkeborg is located on the peninsula of Jutland, where NATO forces maintain a base. Their sophisticated electronic monitoring devices keep watch on Soviet naval movements.

On a clear, crisp night in early October 1979, a Mr. and Mrs. Mortensgaard, managers of a home for the elderly, were enjoying the sights of the city. While photographing the town's more notable landmarks, the Mortensgaards were attracted to the beautifully lit fountains of Long Lake, an artificial lake near the center of town. Using a 35mm camera with Kodak Ektachrome ASA 64 film, the Mortensgaards took three photographs of the fountains. An interval of five minutes occurred between exposures.

Months later, when the couple received the processed slides and projected them, they discovered strange phenomena on the film. Odd light effects were faintly distinguishable behind the images of the illuminated fountains on Long Lake. Unsure of their origins, the Mortensgaards turned the slides over to retired Danish Air Force Major Hans C. Petersen for analysis. As a veteran UFO investigator who has documented hundreds of UFO incidents, Petersen concluded after lengthy evaluation that the photos were genuine. He forwarded the original negatives to Coman VonKeviczky, director of the Intercontinental UFO Research and Analytic Network (ICUFON), in the United States.

VonKeviczky began intensive lab work on the original slides by applying certain photoanalytic processes. Employing microscopy, he could discern no discontinuity in the grain patterns of the object when he compared them to other features in the photographs. He also converted the slides to negatives and enlarged them to 18 × 24 centimeter prints. This technique revealed potential shape, texture, and coloration of the target image. The approximate distance of the target from the camera was fed through a computer, which in turn projected the size of the object. From these and other modes of analysis, VonKeviczky concluded:

- The original 35mm slides did not show any signs of tampering, either manually or by the use of photographic or photochemical procedures.
- Two objects (detected in blowups) were in the air above the city of Silkeborg, between the water fountains of Long Lake and the hilly horizon.
- Between the time of the first photo and the second photo, the objects had moved laterally to the east.
- Computer data revealed the objects to be approximately 800 meters from the camera, the objects measured 30 meters in diameter.

Analysis further indicates that the unidentified objects appeared to be structural forms containing a dark circular fringe upon which a highly polished cupola reflected soft light. The changing light patterns emanating from one of the objects suggest that it moved of its own accord. The two corner lights on the object seem to be retractable, and a dispersed light beam can be seen shining downward toward the ground. In addition, the translucent horizon, seen through the light beam, is evidence that the craft is positioned above the city.

The Silkeborg sighting has all the characteristics of similar reports that now arrive weekly from Europe. Extensive photoanalysis goes a long way toward confirming the existence of unknown phenomena. However, photographs can never be considered prima facie evidence and must be supplemented by the use of empirical data. The future of ufology depends on the integration of all facets of investigation. ∞

The Silkeborg UFOs. Darkroom analysis reveals that the photo taken by tourists is untouched.

CONTINUUM

A NEUTRINO GOES ASTRAY

What has no mass and no electrical charge, spins like a top, and can slip through a light-year of solid lead without banging into anything?

The answer is the neutrino. That is, until recently, anyway. Now the *little neutral one*'s I.D. may need updating—with profound implications for the universe. But it has always been a surprising particle.

The neutrino was "invented" in 1930 by Wolfgang Pauli, who needed a new, unseen subatomic particle to satisfy the laws of conservation of energy and momentum in his calculations of radioactive decay. Like motherhood, these laws are sacrosanct and are rarely questioned by physicists totally committed to an orderly functioning of the universe.

Pauli's neutrino possessed bizarre properties. It had to be massless, to be chargeless, to spin around an axis lying along the direction of motion, and to move at the speed of light. (Only in the quantum world can particles spin without charge or mass.) There is more. Because neutrinos are born in reactions involving the "weak" forces within the nucleus, their connection with all other objects in the world is weak—so weak that a neutrino can pass through the sun in several seconds, or through a light-year of lead, if such a thing were possible on Earth. Fortunately for terrestrial experiments, if you have more neutrinos, you need less material to cause a collision (and "capture" a neutrino).

In 1962 I was involved in an experiment in which, with a paltry three meters of aluminum, we collected 50 examples of neutrino collisions. That experiment led to the realization that neutrinos come in several varieties: an electron neutrino, associated in reaction with the birth of an electron, and a muon-neutrino which cohabits in reactions with another particle, the muon. A third "flavor," the tau-neutrino, associated with the recently discovered tau-lepton, is also believed to exist.

As fundamental to neutrino identity as masslessness was the law prohibiting interactions between different kinds of neutrinos. Just as two blue-eyed parents cannot produce a brown-eyed child, an electron neutrino can't change into a tau or muon variety. Or can it?

Experiments conducted at the University of California at Irvine and at the large CERN accelerator in Geneva, Switzerland (where electron-neutrinos were reported missing in action), have suggested that electron-neutrinos are changing into something else. But what? Is our innocent-looking electron-neutrino "oscillating" into a tau-neutrino or something entirely different?

The mysterious "disappearance" of electron-neutrinos might account for a long-standing puzzle about the sun. Physicists believe the sun is heated by a fusion reaction at the core that generates electron-neutrinos as well as heat and light, but experiments designed to detect the emitted neutrinos haven't turned up enough of them. Either the sun is powered in a different, unknown fashion (a disturbing notion for fusion physicists) or electron-neutrinos, the only kind the detector picks up, are converted into, say, tau neutrinos during the trip from sun to Earth.

If that weren't enough, neutrinos' masslessness is also being questioned. Some of the new "grand unification" theories, which attempt to unify all the forces in the universe (electromagnetic, gravitational, nuclear, and "weak"), propose a small mass for the neutrino. And a group in Moscow, observing the decay of tritium, has concluded that neutrinos have a mass of between 14 and 46 electron volts—minute, but indeed a mass.

This brings us to cosmology. If you have philosophical qualms about living in an infinitely expanding universe, a neutrino with mass would bring heartening news. Here's why. Our astrophysicist friends tell me that they can measure the mass of a galaxy by the properties of the hydrogen atoms that orbit it. (Contemplate the range of numbers we physicists juggle. Mass of a galaxy, in kilograms: 1 followed by 38 zeros. Mass of an electron: 1 *divided* by 1 followed by 30 zeros.) The number arrived at by observing hydrogen is about ten times the mass obtained by counting stars and applying rules associating mass with luminosity.

Then where is the "missing" mass? Dark stars? Black holes? Unlikely. Why would there be only dark stars beyond the range of the visible galaxy? The most plausible explanation, as you may have guessed, is neutrinos with mass. If the particle had a mass of 20 electron volts, elementary calculations show that unseen neutrinos would dominate the total mass of the universe and add up to enough gravitational density to slow the expansion of the universe. Gravitation would eventually draw all matter together again until it collapsed and then exploded again in another big bang. The neutrino's changed identity would give us a cyclic universe. Pauli, look what you started! *LEON M. LEDERMAN*

CONTINUUM

PRIMAL GROWTH

When self-help devotees speak of "personal growth," they don't ordinarily mean it literally. But

People who complete primal therapy (a therapeutic method known for its primal scream) may, in fact, actually *grow*, say the technique's inventor, Arthur Janov, and his collaborator, E. Michael Holden, a neurologist.

Adults may grow 2.5 to 5 centimeters taller; men may sprout full beards and chest hair, and women may develop curves where there hadn't been any. The reason? Removal of stored pain.

The primal-therapy patient undertakes a kind of inner voyage to the sources of embedded pain—in childhood and infancy, even *in utero*. (A few patients have "relived" their mothers' abortion attempts.)

About 20 percent of patients exhibit some kind of belated physical maturation, Holden says. Reliving and exorcising buried pain theoretically releases their full genetic potential.

"We have a model for this in psychosocial dwarfism," Holden notes, referring to well-documented cases of neglected or abused children whose growth was severely retarded.

The brain's limbic system, he says, acts as a sort of "capacitor." The stored pain is responsible for a neurotic, usually hypermetabolic physical state: abnormal heart rate, hormone levels, blood pressure, and other vital signs. It is as if the body were battling a disease, says Holden. When patients complete "primaling," he claims that their vital signs go down to normal.

—Judith Hooper

Does screaming increase height? Primal therapists claim the removal of stored pain releases full genetic potential

MAYAN CANALS

One of the murkiest archaeological mysteries is why the resplendent Mayan civilization of Central America collapsed around A.D. 900. Why did the Spanish conquerors stumble on little squabbling kingdoms? What happened to the highly organized society portrayed on temple stelae at Tikal and Palenque?

A new radar device, used to photograph the moon during the 1972 *Apollo 17* flight, has now been applied to Mayan archaeology—with Rosetta Stone-like consequences.

Mayan jungle civilization was supposed to have lacked the agriculture (and arable land) necessary to feed its expanding populace. But Synthetic Aperture Radar (SAR), developed for NASA by the Pasadena, California, Jet Propulsion Laboratory, reveals another picture.

What SAR aerial "photographs" of the cloud-covered rain forest of northern Guatemala and Belize found, in April 1978, apparently was a sophisticated network of canals in the heart of Maya country. After seeing the aerial images, Richard Adams, dean of archaeology at the University of Texas, and University of Arizona archaeologist T. Patrick Culbert went in by land.

They found canals where SAR predicted them. "This is only the beginning," Culbert notes. "But it looks as if there was once a very impressive drainage system."

In Classical Mayan times (about A.D. 300–900) the Guatemalan city-state of Tikal had about 50,000 inhabitants.

The advanced canal system, Culbert says, could have supported the complex bureaucracy—as well as the Mayas' elaborate cosmology, written language, calendar, and architecture. But the very difficulty of maintaining such a bureaucratic organization in times of stress probably speeded its downfall and the ensuing dark ages.

The SAR produces high-resolution pictures in cloud-covered regions, which Guatemala is. A pattern of "echoes" (or Doppler shifts) is recorded while radar signals bounce off objects. Then the film is illuminated with a laser.

—Judith Hooper

"It's unfortunate, but the way the American people are, now that they have developed all of this capability instead of taking advantage of it, they'll probably just piss it all away."

—President Lyndon Johnson, speaking about Project Apollo

Mayan relic. A great people's demise is still a mystery

KUDZU

The voracious kudzu vine is carpeting the South, growing up to 30 centimeters a day and pulling down telephone poles, saplings, and large trees.

The National Wildlife Federation (NWF) reports that the prolific vine, imported from Asia around the turn of the century, has already covered 400,000 hectares of farms, pastures, and forests in the southern United States. It is now moving north and west into Virginia and Texas. Kudzu can climb 12 meters during its summer growing season, providing shade and purple flowers—and swallowing anything in its path, including vans and lawn furniture.

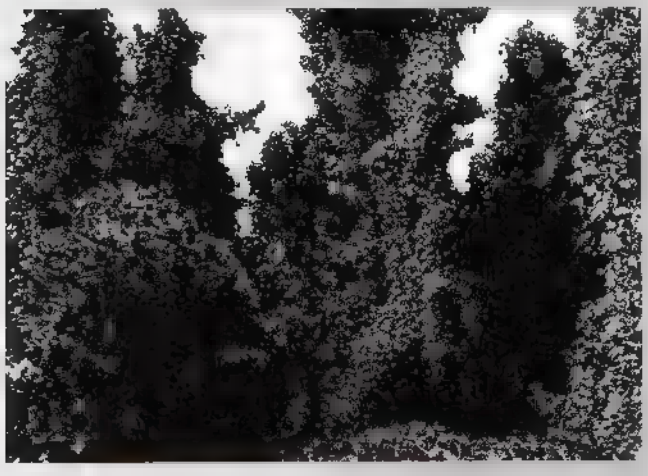
"Once kudzu starts to grow, it doesn't want to stop," the federation reports. Only massive doses of chemical herbicides can kill kudzu, but this remedy would be very costly and would pose many ecological risks.

The plant, with its three-pointed leaf and woody stem, is used by the Japanese to make cloth, paper, and hay. The Chinese grind it for flour. Americans in the early 1900s used kudzu to shade their porches, control erosion, rejuvenate nitrogen-deficient soil, and provide forage for cattle.

Farmers soon found that kudzu was easily overgrazed, leaving behind heavy, wooden stems. Then they watched the plant crowd out their cash crops. So aggressive is the vine that in the 1940s many southern communities formed "kudzu clubs" as a social rite. Queens were chosen. Homage was paid.

The federal government lists the vine as a weed. The NWF puts it another way: "What can leap up a house in a single summer and is nearly indestructible? Look! Up in the trees! It's kudzu!"

—Stuart Diamond



What can climb 12 meters in a single summer, pull down telephone poles, and swallow trucks whole? Look! Up in the trees! It's kudzu!

RAINMAKERS

It is a polluter's dream: a federal study showing that dirty discharges have redeeming value. In this case, government scientists have found that nitrogen oxides released into the air by refineries can help produce needed rainfall by seeding clouds with particles.

The National Oceanic and Atmospheric Administration says that refineries near Los Angeles release gases containing large particles around which moisture can crystallize. The resultant rainfall is welcome in the dry southern California climate. The rain-filled clouds also lower surface temperatures, providing relief for hot areas during the summer.

Ordinarily urban smog clouds contain smaller sulfate particles, which are not as good as cloud seeds. The refinery effluent, however, contains more large particles than do clouds in either urban smog or unpolluted areas.

While the refinery emissions might not add significantly to annual rainfall, they do help produce rain more quickly, said Earl Barrett, one of the government researchers.

The scientists did not study whether the clouds seeded with refinery discharges produced dirtier rain than precipitation from smog-filled city clouds, but they did give a clue as to the nature of refinery discharges. "Distinguishing between smog and refinery effluent was not always easy," said Fam Parungo, another federal scientist.

—Stuart Diamond

California refinery: A federal study shows that dirty discharges contain gases with large particles. The result: Welcome rainfall.

"The effort to reconcile science and religion is almost always made, not by theologians, but by scientists unable to shake off altogether the piety absorbed with their mother's milk."

H. L. Mencken

CONTINUUM

COAL RADIATION

More bad news on the energy front: Coal plants are significantly radioactive

According to Dr. Emmett Bolch, environmental-engineering professor at the University of Florida, the day-to-day environmental impact, or the total combination of air pollution and radioactivity over one's lifetime, is worse from coal-fired power plants than from nuclear-power plants. In a recently released study of the impact that increased coal use has in Florida, Dr. Bolch cites research that states conclusively that the trace elements found outside a coal-fired plant range anywhere from one to eight millirems per year. "That's pushing the nuclear maximum," says Bolch, "which is eight millirems. The emission from a nuclear plant that's functioning normally never gets that high." In addition, Bolch maintains, the cancer rate (0.2 cancers for each year it is in operation) is 200 times higher from a coal facility than from a nuclear one, for which the cancer rate is 0.001 per year of operation.

Dr. Harry Gove, director of the Nuclear Structure Research Laboratory, at the University of Rochester, New York, agrees with the findings. He points out, however, that "standing on a street corner is far more dangerous than standing next to a coal or nuclear power plant, since the background level of radiation emitted from passersby and granite buildings is about one hundred thirty millirems."

—Ellen Bilgore

"Outer space is like Dolly Parton: You don't believe it but there it is."

—Lorne Greene

A rebirth of the Coal Age may result in significant radiation

VEGETABLES, WOMEN, AND CANCER

Female vegetarians may stand a better chance of escaping breast, uterine and ovarian cancer than their meat- and fat-eating sisters.

Oregon State University researcher Terry Shultz studied 23 female volunteers in a large nutrition experiment. Fourteen were members of the Seventh-day Adventist Church, whose vegetarian adherents are known to have lower-than-average cancer rates.

A vegetarian diet may reduce a woman's risk of cancer

The vegetarians in the study had lower levels of the sex hormone estrogen than did the meat eaters. Medical research has linked high estrogen levels to breast and uterine cancer.

(A recent report by Samir Shapie, of the National Cancer Institute, suggests that high levels of estrogen in women's tissues may overwhelm natural inhibitory factors that prevent the growth of cancerous cells.)

Jim Leklem, who supervised Shultz's work, says they made sure there were no other variables that could have had the estrogen-lowering effect. "We screened out people taking drugs or with illnesses that affect estrogen levels," he said.

The ages at which the younger women began menstruating and the older women reached menopause had no effect on estrogen levels.

The researchers didn't know, however, whether the vegetarian women, with their lower-than-usual estrogen levels, also had weaker-than-usual sex drives. "We did not look for that," Leklem admitted.

The next step is to conduct more tests with a larger population. Meanwhile, Leklem suggests, women may reduce their risk of getting cancer of the uterus and the breast by reducing the amount of meat fats and fried foods in their diets.

—Joel Davis

"True science teaches, above all, to doubt, and to be ignorant."

Miguel de Unamuno

LIFE FROM THE CLOUDS

Life began in dense, hot clouds surrounding the earth about 4 billion years ago, not in chemically rich waters below, a biologist suggests.

Carl R. Woese, of the University of Illinois, theorizes that carbon dioxide from volcanic gases created a

"greenhouse effect," trapping heat from the sun so the earth's surface soared to temperatures as high as 540°C or more.

There were no oceans. Swirling dust storms pushed salt and other chemical particles up into the Venus-like clouds containing carbon dioxide, hydrogen, and other gases. Fine droplets of cloud mist became templates for cells. Sunlight struck chemicals collected on the droplets, initiating chemical reactions and photosynthesis. Chemistry for life developed from chemistry taking place in the cloud droplets.

Thus began the first life forms, which Woese calls archaebacteria. They were methanogens (producing methane gas), he says, and now they are probably the most primitive forms of life on Earth, separate from plants and animals and bacteria.

As the early earth cooled and as oceans formed, the ancestral archaebacteria floated down and new life forms evolved from them.

Woese, a professor of genetics and development at Illinois, says his theory grew from tracing the genealogy of life through genetic chains, back to a simple, universal form that presumably preceded present-day life. NASA and the National Science Foundation have funded his research.

—Alton Blakeslee

"O Bomb I love you
I want to kiss your clank
Eat your boom"

—Gregory Corso

ROACH RESISTANCE

Despite recent scientific efforts to wipe them out, and the fact that cockroach traps are a $10-million-a-year industry in the United States, the cockroach remains a hardy survivor.

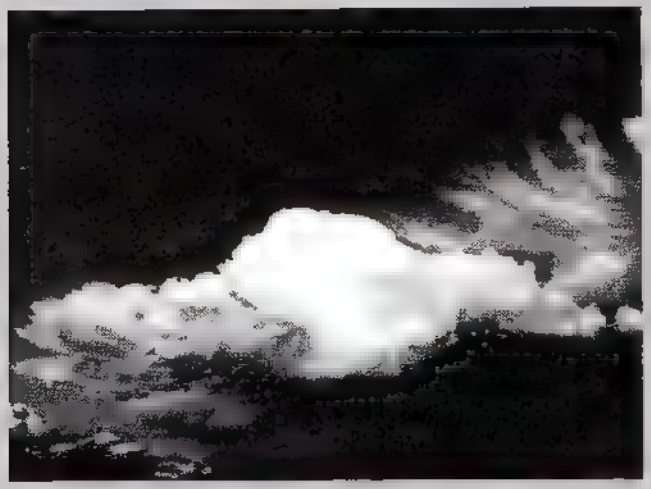
Recently some Dutch chemists studied 75,000 female roaches and found the scent that attracts male roaches. The chemists then synthesized the substance, hoping to trap some males. However, since female roaches can reproduce without males, their trouble may be for naught.

Other researchers put roaches on treadmills and attached the little bodies to a phonograph stylus and oscilloscope. Then a jet of air was directed at the short hairs on the roach's tail—producing a draft of air like that which a roach feels just as someone tries to swat it with a newspaper. The researchers found that the air caused the hairs to activate the leg muscles, sending the roach scurrying away in five hundredths of a second. The impulse did not go through the brain; that would have taken longer. This is why it's so difficult to hit a roach.

Meanwhile at least two U.S. companies have had some success selling small cigarette-box-like traps that have one-way doors and a food scent that the insects seek out. But roach expert Betty Faber, of the American Museum of Natural History in New York, contends the traps "only catch the losers."—Stuart Diamond

"Whoever wins to a great scientific truth will find a poet before him in the quest."

—Frederic Wood Jones



An Illinois biologist suggests that life on Earth began not in the oceans but in the clouds with creatures called archaebacteria

Despite science, the ancient roach lives on . . . and on and on

CONTINUUM

INDOOR POLLUTION

The air-pollution levels in the kitchen of a well-insulated house may be three times those found in smoggy Los Angeles, researchers have found. The reason: Carbon monoxide from the gas range can no longer escape the house as easily.

In modern office buildings the "Monday morning sickness" of some people may be a physical reaction to trapped cigarette smoke, formaldehyde-based insulation, or combustion products from cooking and heating systems.

Moreover, recurrent eye irritation and headaches may be due to fumes from office photocopiers or from household cleaning fluids. The offensive fumes may linger for several hours.

As if to confirm the law that every action has a reaction, the move toward tighter, more energy-efficient buildings is leading to a subculture of sufferers from indoor air pollution. Most Americans spend 70 percent of their time indoors. While the Clean Air Act is intended to improve the air outside, the new energy creed is often making it riskier to be indoors than out.

Old-fashioned buildings have two to four complete changes of air every hour. But very well insulated modern buildings with sealed windows may have one air change only every ten hours. So the noxious fumes stay around.

One solution is to bar pollution sources: cigarette smoke, cleaning fluid, fuel sources, formaldehyde insulation.

Another is to filter and ventilate indoor air. Commercial aircraft can clean and recycle their air up to two dozen times an hour. Some new devices activate building ventilation systems when monitors detect elevated pollution.

People who cook with gas ranges in well-insulated homes have been encouraged to use exhaust fans. "We must balance energy conservation with a healthy environment," says Richard Duffee, an environmental consultant.

Stuart Diamond

"Science is built of facts the way a house is built of bricks, but an accumulation of facts is no more science than a pile of bricks is a house."

Henri Poincaré

THALIDOMIDE RETURNS

For many people, the name *thalidomide* still evokes nightmarish images of children born without limbs after their mothers had taken the drug as a sleeping pill during their pregnancy. But now, 20 years later, thalidomide is returning as an experimental drug, with a surprising ability to cure a rare skin disease and to treat certain kinds of leprosy.

Thanks to the new energy consciousness and increased insulation, cigarette smoke and other noxious fumes stick around much longer

Researchers in South America, Germany, and Israel and at the University of Chicago report that thalidomide can alleviate prurigo nodularis, a skin ailment that causes rashes and growths like boils. "It's the only treatment we've found that is successful in clearing up the skin," said Dr. Hans van den Broek, assistant dermatology professor at the University of Chicago.

Dr. Van den Broek administered the pill daily for about three months to a patient at Hines Veterans Administration Hospital, in Illinois. The rash disappeared and the lesions flattened. The dermatologist also cites recent experiments that show thalidomide prevents the nerve paralysis that sometimes accompanies leprosy.

The patient with prurigo was an older male. The U.S. Food and Drug Administration, which approved the experimental treatment, noted that thalidomide's publicized problems occurred only among pregnant women. Long-term use, however, may cause mild nerve disorders, such as tingling in the hands. "There are still risk/benefit questions," said Dr. Carnot C. Evans, the FDA's chief dermatologist. "The evidence

Leper: Hope from thalidomide

must be carefully weighed.'

Otherwise, the drug is relatively nontoxic. Suicide attempts with large amounts of it have been unsuccessful, according to the American Medical Association. The would-be suicides simply slept. — Stuart Diamond

HEAVY METAL

How are your lead levels today? This could be a question heard regularly by workers in Sweden's lead industry and related industries. Under an experimental program launched in cooperation with the National Swedish Board for Occupational Health and Safety employees exposed to lead will now be included in a new "lead register."

The testing procedure remains what it has been since the 1950s. Blood samples are sent to a laboratory, where they are measured and the results are forwarded to the companies and the Board for Occupational Health and Safety, which compiles and stores the data. Formerly this would be the end of it.

However, everyone participating in the experimental program now gets a personal computer chart in the mail showing his or her blood-lead level. Thus, employees can monitor themselves. Participating companies even receive "corporate charts," profiling their employees as a group. This gives both companies and employees an early-warning system, allowing them to react fast in the event their lead levels appear to be increasing dangerously.

If this new lead register does manage to get the lead out, other projects are planned for more potentially dangerous substances in the working environment. Topping the list are styrene and asbestos. The system can also be used for other types of monitoring, such as gathering data on noise levels. — Don Hinrichsen

Swedish lead worker: Blood samples are analyzed, and a personal computer chart showing lead levels is sent in the mail

Plum Island: The elite animal-disease specialists on this New York island are attempting to engineer a foot-and-mouth vaccine

FOOT-AND-MOUTH

In an unusual agreement between a West Coast gene factory and government researchers, scientists will attempt genetically to engineer a cheap vaccine for one of the world's biggest killers of livestock, foot and-mouth disease (FMD).

The cooperative agreement was worked out between Genentech, Inc., a San Francisco-based research company interested in commercial applications of recombinant DNA technology (see "The Gene Trust," April 1980), and the U.S. Agriculture Department's Plum Island Animal Disease Center, an isolated laboratory for elite animal-disease specialists off the north coast of Long Island, New York.

"They supply the bacteria, and we supply the technical information," Dr. Jerry Callis, director of the Plum Island Center, succinctly explained. By combining the center's 26 years of knowledge and experience studying FMD viruses and Genentech's ability to restructure fast-growing bacteria genetically, the scientists hope to mass-produce a vaccine against one of the 12 viruses implicated in causing FMD.

Vaccines in use now are grown slowly in tissue cultures, are hard to store and transport because of their delicacy, and are sometimes of uneven quality.

A genetically designed vaccine, however, could be produced cheaply in large batches of uniform quality and could be transported and stored without refrigeration. An inexpensive vaccine like this will directly benefit parts of the world where the disease accounts for billions of dollars in lost livestock each year. Indirectly it will benefit the 200 million livestock in the United States that are completely susceptible to the virus, by minimizing the threat of disease. — Douglas Colligan

CONTINUUM

MONKEY LOVE

Most scientists have assumed that female orgasm is unique to the human species, that females of other mammal species do not experience the physiological changes that sometimes accompany copulation.

Now an eight-year-old stump-tailed macaque monkey at the Netherlands Primate Center has proved them wrong. Telemetry signals from battery-powered transmitters implanted in her body showed strong uterine contractions and an accelerated heartbeat when she was engaged in sexual activity with another female. At the same time the monkey pursed her lips into an O shape, made rhythmic sounds, and manifested body tenseness—all indicative of orgasm in male macaques.

This particular female was chosen for the experiment because she had shown what looked like orgasm when she mounted another female the way a male monkey would.

Dr. David Goldfoot, of the Wisconsin Regional Primate Research Center in Madison and several Dutch colleagues implanted three transmitters into the monkey's body, two in the uterine area and one in the chest area. When she recovered, she engaged in the same sexual play with the same partner. The transmitters showed she was experiencing orgasm.

The first proof of female orgasm in monkeys came from female pairs, but Dr. Goldfoot has since obtained telemetric evidence from heterosexual pairs.

"One of the reasons why we are excited about these findings," Goldfoot said, "is that we now have a true animal model for female orgasm. We can ask questions about both the physiological and the psychological factors in orgasm."

Barbara Ford

Two female monkeys: Display of the round-mouthed "ejaculation face" was partial evidence that female macaques attain orgasm.

CELL MOVIES

With time-lapse motion pictures taken through a microscope, John Hlinka sees living cells that move like inchworms, dance, and penetrate other cells.

The cinemicrographs are adding knowledge about the behavior of cancer cells, says Hlinka, of Memorial Sloan-Kettering Institute for Cancer Research, in New York. His films can show whether a chemical added to a cell culture kills cells or merely stops their reproduction—in either case a good thing—or they can determine exactly what else has happened.

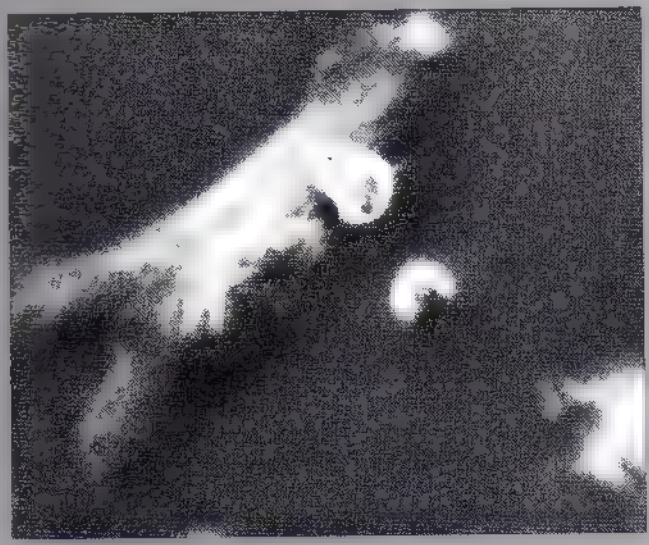
Using a special chamber that allows cells to be rotated in the microscope, Hlinka can view them from the side, instead of only looking straight down on them, to see whether they actually let go of the substrate.

So-called killer cells (part of the body's immune system), sensitized to attack tumor cells, seemed to dance around the cancer cells, prying them off the substrate with spikelike pseudopods. Then they penetrated the tumor cells, boring out the other side.

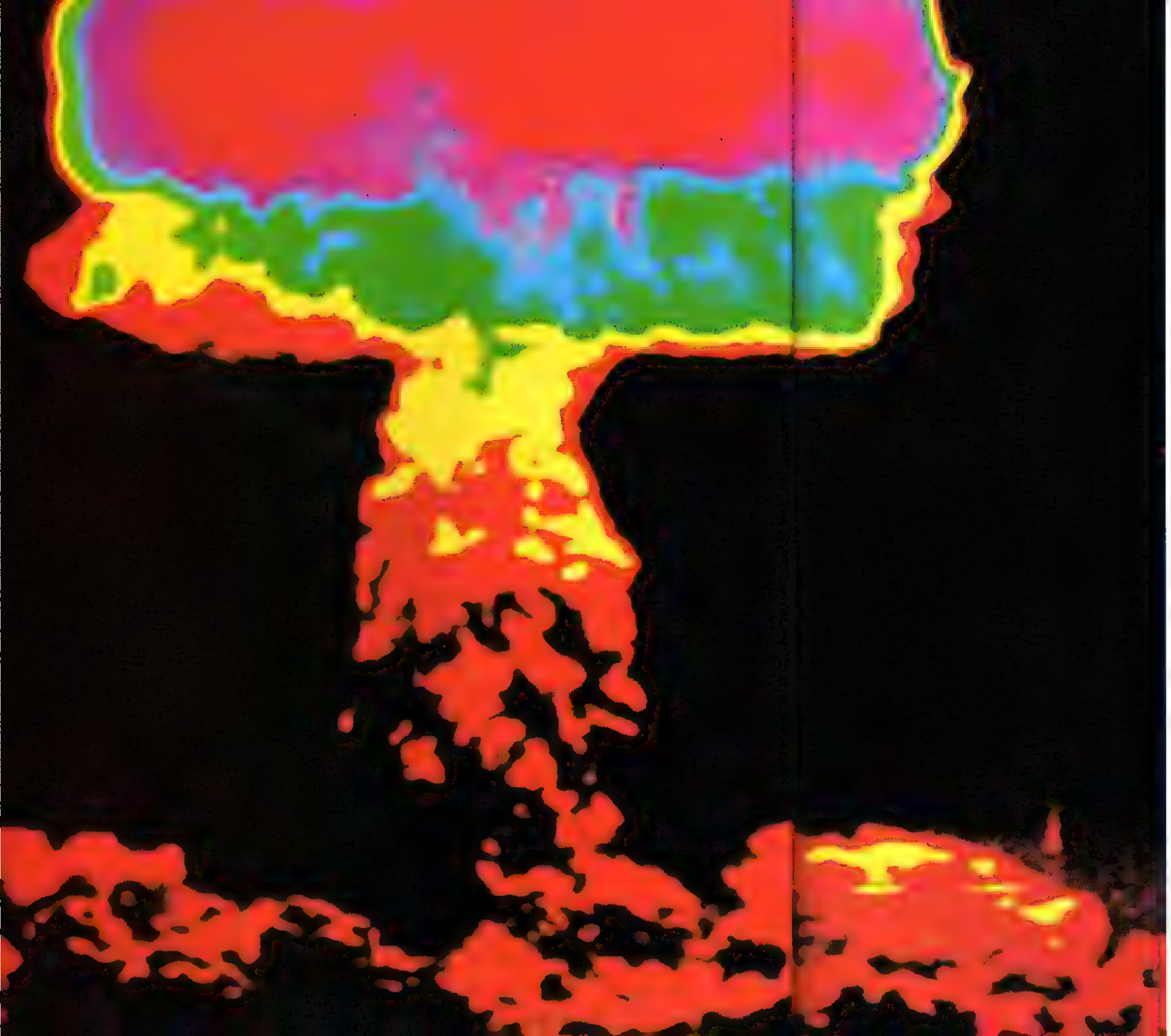
"The lymphocytes killed the tumor cells literally by worrying them to death. They are the only cells I know that can go into another cell and survive," Hlinka says.

The film, usually made with Kodak Plus-X reversal film 7276, "is like a time machine. We can go backward and forward in time through the entire experiment as many times as we want. If we miss something the first time, we can always see it later."—Alton Blakeslee

'Scientists should be on tap but not on top.'
—Winston Churchill



Hlinka's pioneering photos of killer cells. Sensitized to attack tumor cells, they destroy cancers by "worrying them to death."



High-budget, low-profile think tanks ponder world wars for the top brass

FOR YOUR EYES ONLY

BY PAUL J. NAHIN

In a sleek, black building, shadowed by the Pentagon, young men sit and think about the death of millions. In their neat, nondescript offices, they ponder such questions as: Should the Defense Department consider using personal targeting as a deterrent to war? Should foreign leaders and decision makers know that in any nuclear confrontation we might be gunning for them *personally*?

The answer to each question is yes.

The building, which looks like Darth Vader's sanctuary, houses the Institute for Defense Analysis (IDA), one of America's two dozen military think tanks that spend about $500 million of our tax dollars each year studying the likelihood of, and our readiness for, World War III.

Each one of our armed forces has its own specialty think tank. The Air Force has the Rand Corporation, the Navy has its Center for Naval Analyses. But IDA is the five-star general of military think tanks.

If such questions as zapping individual opponents are being allowed to leak through IDA's tight security, imagine what top secret machinations go on that the public doesn't know about.

In fact, you'll have to use your imagination because there's no chance IDA will tell you. It speaks only to its government patrons. Just because IDA's $30 million annual budget is funded by the public, there is no

PHOTOGRAPH BY HOWARD SOCHUREK

reason for it to tell the public anything. Secrecy is rigorously maintained.

If you call the Institute for Defense Analysis and request a list of current in-house unclassified publications, you'll be told as I was, "I'm sorry, but there is just no such thing." And if you ask for DA's annual report, you'll be told, "Yes, there's one, but the 'annual' report is prepared only once every five years." I finally got one for 1970 because the 1975 version is out of print and the 1980 one was unavailable. That's what's meant by "keeping a low profile."

But secrecy doesn't mean that the style of a think tank has to be a secret, too. Just what is such a place as DA like? How do the people there do their work, and what exactly, is it that they do? What kind of people work in a military tank? How is what they do different from the work done at a government laboratory or for a private technology outfit? And how will these military thinkers affect our future?

To understand all this, first forget the idea that think tanks are full of scholarly looking types with elbow patches on their corduroy jackets, smoking pipes while thumbing through books filled with equations. Dozens of places throughout the United States "think" about all sorts of various problems. But there is little room in any successful tank, military or otherwise, for the totally devoted thinker. A successful think-tanker is not a professor.

Replace that image of deep thinkers with one of fairly young Ph.D.'s. Most are under forty, having scant practical experience as design engineers, research scientists or technical managers. Often their experience, when they are first hired, is zero. Couple these "qualifications" with a driving ambition to be where the action is and a seemingly contradictory willingness just to be part of a report-writing committee. Throw it all together with a bit of romanticism and a love for answering strangers at a party with these words: "Gosh, I wish I could tell you what I do for a living, but just can't. It's all hush-hush stuff for the Joint Chiefs."

Does all this remind you of someone fantasizing about Humphrey Bogart being seduced in *Casablanca*, or John le Carré's George Smiley skulking about in the back alleys of Zurich? Indeed, this seems to be the self-image think tankers have.

Of course, this isn't a description of every military think-tank staff member, but it fairly describes most of them. Ironically, the motivation of today's think tank staffers differs notably from that of their predecessors.

In 1942, faced with the imminent threat of German U-boats cutting Atlantic shipping lanes, the federal Office of Scientific Research and Development signed a contract with Columbia University, in New York City. This pact formed the Antisubmarine Warfare Operations Research Group, which then applied the analytical methods of physics and mathematics to a host of operational naval problems, such as determining the best way for a surface ship to evade a kamikaze attack.

This highly successful work was done by experienced civilian scientists working in interdisciplinary teams. Since the Navy felt that such creative people would not work well in a rigid military structure, the decision was made to adapt the best aspects of a university environment to the Navy's requirements for secrecy. This kind of organization has continued to the present.

Another reason why the Navy formed a civilian group was to get around the low pay of civil servants. In those early days, free from congressional regulation, think tanks could pay employees much better salaries than scientists working at government laboratories could command.

Today however the situation has actually been reversed. For example, the entry level civil service grade for a brand new Ph.D. twenty-five years old with no experience, is GS-12, paying a minimum of $24,703. Such a person would be assured a generous retirement plan, virtually automatic cost-of-living raises, and the near equivalent of

"The new military think-tank staffer is like a huge sponge, sopping wet with knowledge. But as the years go by, he gets squeezed dry. And a dried-out sponge isn't worth much."

academic tenure. Hence, government service should be more attractive now than any civilian think tank.

So why do people work for the military think tanks?

What it boils down to is that military think tanks attract the sort of person who isn't motivated toward research but prefers an academic atmosphere, likes to think he has a personal pipeline to Pentagon decision makers, and enjoys such pleasant perquisites as an international airline travel card. Government labs attract either the dedicated researcher or the reasonably competent but possibly lazy engineer who prefers a warm, cozy niche.

The government lab operation offers researchers the opportunity to work on theoretical studies or with real hardware. An agency such as DA however has precisely one product, words: reports and top-brass briefings, the printed word on lots of paper, and slickly done, multicolored presentation charts. The Ph.D. who can't write and is too shy to talk on his feet in front of strangers won't fit in.

Such an environment can be dangerous for the long-term growth of the individual. With no basic, or even applied, research going on, the Ph.D. is at the outset like a big sponge, sopping wet with the very latest knowledge. As years pass by, however, and as he spends all his time writing reports, he is squeezed dry. There are no regular recharging processes: no periodic academic sabbaticals, no private consulting, no teaching. And a "dried-out sponge" isn't worth much to anyone.

Private industrial labs, like those conducted by Hughes Aircraft, attract a third entirely different kind of individual. There you'll find young professionals who are excited about working on the edge of the applications of existing technology.

Industrial lab workers, unlike those at a think tank, are profit motivated. Very few do the "blue-sky" conjecturing that think tanks encourage. For those who get the chance however it can be exciting. One of the high points during my years at Hughes, citing one personal experience, involved an assignment to "think crazy" about how to do kill assessment with an anti-aircraft laser cannon. I recently recounted this to a friend working at a Washington, D.C.-based military tank.

We had the following curious exchange.

Nahin: The big problem with a laser cannon, of course, is the expense of shooting. If you've killed the target with your previous shot, you don't want to waste energy on another shot. If you've missed, you damn well do want to shoot again. So that's the problem. How do you tell, fast, whether the last shot killed the target?

Friend. Okay, I've got the picture. So what did you come up with?

Nahin: Well, it's simplicity itself. You attach a small telescope to your cannon, set it to watch the target optically and you feed the light from any explosion fireball that occurs to a spectrometer. If you've hit the pilot and vaporized him, you'll see a sudden, intense carbon line. Then as the mist dissipates in the wind, the carbon line will weaken and fade away. If you don't see the line, you take another shot.

Friend. God, that's gross! What did the people at Hughes say about it?

Nahin: Same thing: grossest thing they'd heard in a long time. Still, it is an intriguing thought, and I think they assigned somebody else to think some more about it.

Typically military tankers don't work alone. A group is assigned to each problem, with one person designated as the study leader. The group can be as small as two or as large as a dozen. Small groups take on studies lasting less than six months, larger groups work together from five months to a year.

These groups do little or no original research. Lack of understanding on this point leads to disenchantment among many new staffers, with the result that many people quit during the first year of employment.

What the study group does is identify all the military and civilian research labs and industrial contractors who are researching the problem area. The group then attempts

to pump a the data, opinions and advice t can get The fact that the military tank does not compete for federal research grant money helps to loosen tongues Even more important is the realization that what the tanks final report recommends to sponsor may determine who w get new money

A good example of the modern military think tank is the Center for Naval Analyses (CNA), which evolved from the Navy's original Columbia group Located in Alexandria, Virginia, down the road from IDA, CNA is managed for the Navy by the University of Rochester It does not enjoy IDA's broad based support at the highest levels In the Pentagon but instead it receives a more limited mandate along with a corresponding ly smaller budget of about $15 million from the Office of the Chief of Naval Operations But this doesn t mean it thinks only about second-rate problems

Indeed, a huge naval headache that CNA is mulling over has enormous implications for the future of the world

America's strategic military posture is based on the concept of the TRIAD a three pronged offense These prongs are land based, nuclear tipped ICBMs strategic bomber forces, and Trident nuclear submarines armed with low flying cruise missiles It is plausible that the Soviet Union might achieve a technological surprise that would negate one of these prongs But the argument goes it is utterly inconceivable that Soviet planners could blunt all three So the credibility of our ability to destroy the USSR, if sufficiently provoked is strong But is such a bitter Soviet breakthrough really so outrageous?

The TRIAD technologies are constantly under attack Suppose the CBMs are rendered impotent by space based laser cannons and particle beam weapons Suppose, further that our bomber forces are shot down by ever more sophisticated interceptors long before they reach the Soviet Union That leaves only the subs

A former CNA employee recently outlined the problem for me Submarines are hard to detect only if they remain submerged Once they surface, they invite rapid destruction by antisubmarine aircraft, which the Russians possess in abundance Unfortunately subs can t communicate over long ranges by radio when they are submerged because seawater is a good electrical conductor and radio waves short out before they travel very far So submerged subs are on their own out of contact with their military command

To communicate, a submerged submarine must send its antenna to the surface with a buoy Developing Soviet technology, however will soon be able to detect the water waves caused by these small transmitters The subs could then be depth-charged from the air In response to this dilemma the Navy, and CNA came up with Project SANGUINE

Originally conceived as a 55 000-square kilometer, 0 5 billion watt buried antenna SANGUINE would operate at the extremely low radio frequency of 45 Hz (seawater is a better transmission medium at lower frequencies). The Navy claimed such a system would allow radio communication with submarines deeply submerged without any surface contact

Significant social and political problems beset the Navy however, once the people of Wisconsin and Texas found out that their yards were to be dug up for SANGUINE Interestingly, a similar situation is developing now as the people of Utah and Nevada are beginning to understand the implications of the Air Force's decision to plant the MX missile system in their vicinity

More problems for SANGUINE arose when Michael McCintock, of Clark University in Worcester, Massachusetts, and Alwyn Scott of the University of Wisconsin at Madison published a paper in *Environment* magazine

Their paper presented cogent technical arguments that SANGUINE was not a communication command and control system at all but a means for coordinating an American first strike launch of submarine missiles against the USSR They fingered SANGUINE as the critical link in a doomsday machine. The entire concept then seemed to die in the face of massive popular opposition Then it came back to life renamed SEAFARER and again died But now my former CNA contact tells me the

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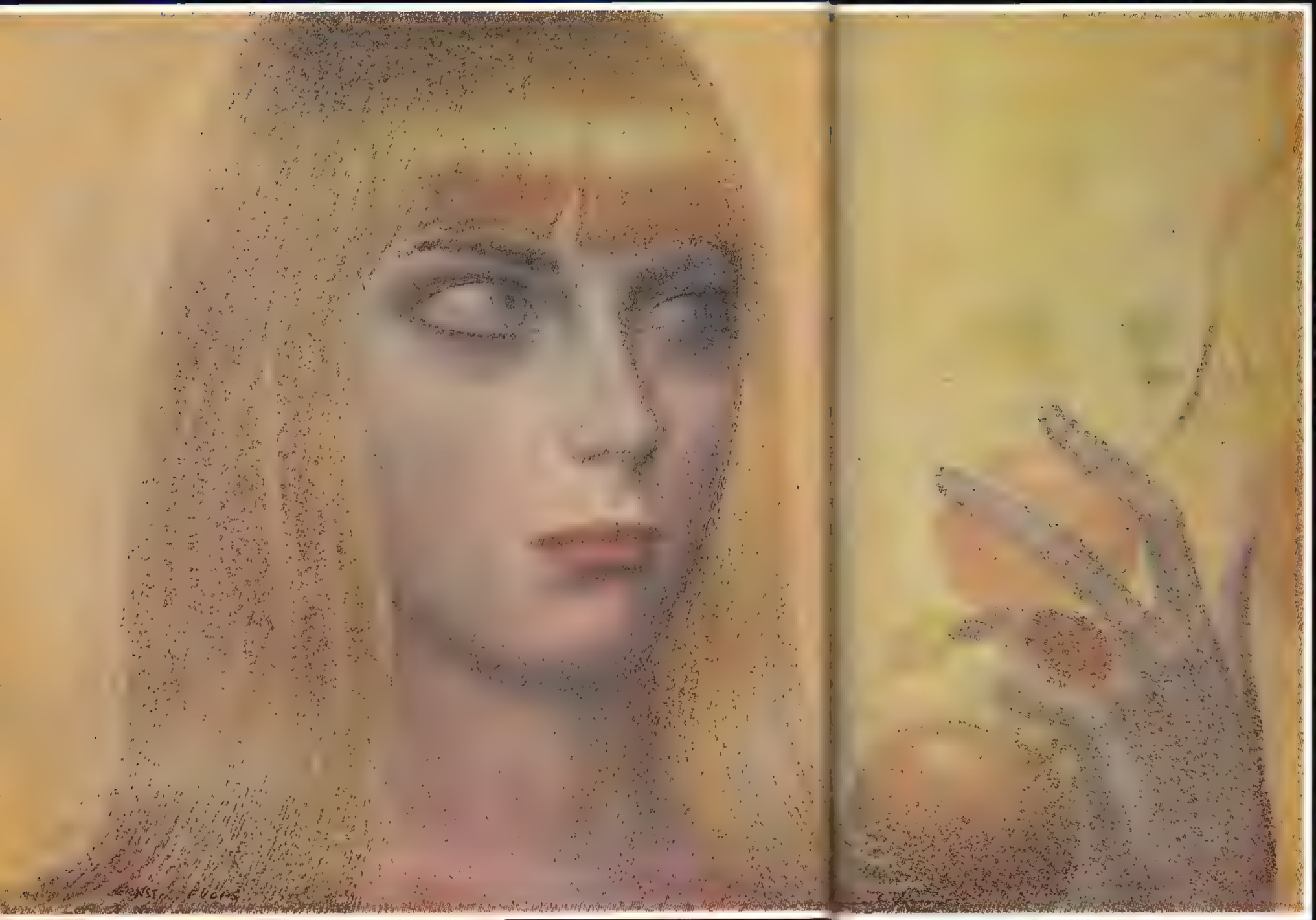

FICTION

THE HUNTING OF HEWLISH

They were out to snare a sailor and found themselves caught in their own trap

BY SAM NICHOLSON

Sibyl stood at the vast, blue-tinted window, swept aside the gossamer draperies with both arms, and gloated over the blue Azorean Sea; over floating gardens, lily-padding in clusters; over helix-caged towers like the one in which she was so luxuriously installed.

"Oh, Roxanne, come and see!" she called to her twin sister.

Roxanne tied the jeweled belt of her chatoyant silk dressing gown and stepped to the window. The girls were blondes of rare beauty, not identical, but complementary.

"What shall we do first?" Sibyl asked, smiling.

"Go hunting, of course," replied Roxanne. "What else is there to do at a holiday resort?"

"Whom shall we hunt?"

"The wealth of the galaxy has come for the regatta."

"Oh, I'm bored with wealth. We don't need wealth."

"We'll need it later."

"We'll hunt it later. Who else is here?"

"The rulers of the galaxy."

"We'll hunt rulers when we're ready to mate."

"You're very difficult today, Sibyl. There's no other prey than wealth and status."

"Nonsense. If we look, we'll find exciting prey."

They stood shoulder to shoulder, hand in hand, and watched the scene. Far below, gleaming white sails fluttered at an edge of the floating platform. The sails tightened, skimmed

PAINTING BY ERNST FUCHS

like low-soaring birds over the deep blue Terran waves.

"How beautiful!" Roxanne exclaimed.

"From here, yes. A wretched sport. One climbs into a narrow shell that dips and tilts—and the sun inflames the skin—and the salt foam stings the eyes—and one must grasp horrid wet ropes."

"We've never hunted sailors."

"That's true. But let's hunt them on land."

"A hunt is a hunt, dear Sibyl. Shall we share or divide our prey?"

"Sailors are not wealthy men. Even a whole one apiece will scarcely make the hunt worth the effort."

"How can you be so stupid? Sailing is a wealthy sport."

"And therefore, dear Roxanne, the sportsmen are poor."

Sibyl turned with a flouncing of lace and sank into the soft cushions nested on the opalescent floor. She picked up a crystal cube and pressed it.

An inner wall of the room became a viewing screen. Rainbows pinwheeled into infinity as a voice asked, "Animal, Vegetable, or Mineral?"

"Animal."

"Primates or nonprimates?"

"Primates."

"Human or subhuman?"

"Human."

"Terran or Galactic?"

"Hold!"

The pinwheels froze. Sibyl called to Roxanne. "Come and help me. How do I answer? There are sailors on all the water planets."

Roxanne swung from the window-and sat besides her sister. "Well, do we want to hunt Galactics?"

"I really can't like Galactics. They're either the wrong shape or too knobby or wear their ears and eyes at disconcerting angles."

"Then you know the answer."

Sibyl restarted the pinwheel and said, "Terran."

The voice intoned, "Name the categories from the greater to the lesser."

Sibyl sighed and said carefully, "Human sports. Sailing. The Atlantic Rift Regatta. Now inform."

The pinwheels gave place to a panorama of the sailcraft now jostling for position beyond the starting buoys for the first race.

"Oh, drat," said Sibyl. "I programmed wrong. These are only the boats."

"You should have continued the categories and said 'Teams.' Now you'll have to begin all over again."

"I won't. I hate voice programming. It was my worst subject at school. Roxanne, dear, begin all over again for me."

"No. Let's watch the boats. How else can one hunt sailors?"

Sibyl leaned back against the cushions, one arm curved over her head. "I wonder. Does passion rose scent go with satin?"

"The boats are very beautiful."

Sibyl's smooth, curling lashes sank to rest on her cheeks, and she slept.

The race took all afternoon to sail the ancient Olympic circle. Roxanne followed the maneuvers closely. When the race was over, she softly ordered the screen, "Hold for further category."

The three-dimensional scene froze in its exuberance of sail and spray. Roxanne looked at her sister. Sibyl's face was peaceful, her eyes still shut.

"Teams." Roxanne murmured to the cube. "Today's winner. Now inform."

A sailboat flashed onto the screen and froze for a moment while the voice said, "Name, *Terran Hope*." Another flash and a grizzled, still handsome old salt stood there, a broad smile on his face and a sharp squint to his eyes. The voice said, "Name, Captain Mack."

"Truly a brave breed," Roxanne observed, to court wind erosion of the flesh and solar burning."

One after another the *Terran Hope*'s crewmen were displayed on the screen, until a firm jawed young man looked into

"One after another the Terran Hope's crewmen were displayed on the viewing screen, until a firm-jawed young man looked into the lens. He frowned, as if resentful of the media."

the recording lens. They scrutinized his handsome face. He had a serious countenance and was frowning slightly, as if resenting the necessity of facing the throng of reporters gathered for the regatta.

The voice intoned, "Name, Hewlish."

Roxanne gasped, "Hold!" She studied the young man, then said, "Clear!"

The screen resumed being a wall. Roxanne jumped up. Sibyl stirred and opened her eyes drowsily. "Where are you going?"

"Hunting. Will you come?"

"Beating the bushes isn't my style."

"No, dear Sibyl. You're the python coiled on a limb above the water hole."

"The regatta teams will be at tonight's ball. Good hunting, sister."

Roxanne left the room and entered her dressing alcove.

Sibyl lay dreamily winding a blond curl around one pearly finger. "Hewlish—the hunting of Hewlish."

The sailcraft bobbed in their slots about the yacht basin, prows to the piers and stern lines to buoys aft. The sails had been taken down and stowed away, carefully, and the masts were but skeletons of glory.

The sailors were still leaving the boats. Only Captain Mack and young Hewlish remained aboard the *Terran Hope*.

The skipper eased the tension of the jibstay, walked them aft to the cockpit where Hewlish was sitting, and grunted, "Coming ashore? We won't be altering anything for tomorrow's race."

"I'll stay awhile, Captain. I'm enjoying the sea wringing my holiday of every drop."

"You're fatigued."

"I'm enjoying that, too."

"As you like."

Captain Mack turned toward the bow again, but stopped. A slim, white cloaked girl, sun cowled and gloved, was standing on the pier. Under the cloak her daytime suit clothed her in gold from her cushioned soles to her throat.

She spoke in a low voice. "Captain Mack, congratulations. I'm Roxanne. May I come aboard?"

"Sorry, no."

"Why not?"

"To be frank, I know about you and your sister. The huntresses. The *Hope*'s win today gives us honor, not wealth."

"I'm not hunting now. I'm curious. What is this satisfaction for which you roughen and abuse your body?"

Hewlish had come forward from the cockpit. "The freedom of direct action, without robot interference." He spread out his palms. "These hands haul the sails."

"Thus you've bruised and wounded them."

"And toughened them."

"How strange! I thought you would say the beauty of the boats fascinated you."

"The aliveness of the boats. My own aliveness. It's a feeling Terra lost many centuries ago. Look at you, Roxanne—cosseted, eating what robots give you, making up deficiencies with pills instead of with air and sunlight. A huntress? I pity the fool who lets you catch and breed him."

"But I'm not hunting now. I don't understand the aliveness of sailing. Can you explain it?"

"It can't be explained, only experienced."

"Take me sailing."

Captain Mack growled, "Ask at the other boats."

"No. I expect to be drenched, buffeted, bruised, and salt stung. The only compensation will be the undergoing of the frightful ordeal with the winners."

"You'll get seasick, too," the skipper grumbled.

"What is seasickness?"

Captain Mack smiled. "Want to sail, hey? Come here at 0 nine hundred hours tomorrow, Hewlish and I will take you for a short run before the wind freshens."

"Thank you. I'll be here."

She bowed and walked away, swiftly and gracefully.

Hewlish asked, "Why did you do that?"

"To get rid of her. She'll forget and oversleep. Huntresses don't rise early."

"Why would men pay to have her? Sex s free reciprocal.

t's not payment on demand The men enjoy—and bestow, endow."

"What for? It doesn't seem ogica

" t s not it's a primitive magic—a bewitchment Stay clear of Roxanne and Sibyl, Hew sh, or before you know it, you ll be without a cred t to your name

"Heed your own warn ng, sk pper. You were the one who nvited her aboard

She won't come Don t st here wondering about her There'll be p enty of women at the ball ton ght '

The first-race ball was past ts ful tide and on the ebb when Captain Mack ar rved c ad n his dress un form. He saun tered around the c rcumference of the great circu ar hall smiled benevolently at the dancers, bowed here and there to acquaintances and f na y set his course for the tab es .n the refreshment bay

A one at a near tab e sat Hew sh, correct y but not fest vely attired He beckoned the capta n to join h m

Capta n Mack seated h mself and said I thought you d have pa red off and been gone by now

"Pa r ng seemed too rout ne too out and dr ed The women seemed dul. sup pose it's the r contrast to Roxanne '

"What cou d you see of Roxanne? Just a shadowed face ns de a hood "

"We l, I can t get her out of my mind Maybe it was her vo ce, or her manner"

"So you've been waiting for her?"

"She didn't come I don't know what I've been wait ng for When d d you get here?

ust now—to be courteous to the regatta committee 'm singleminded about regattas Women don't nterest me when I'm competing All think about s winn ng "

The winning boat will have to compete on Tr vector A shallow, rocky sea, and the three moons play havoc w th the tides. The Trivec scouts are here.

Let em scout Cou d you crew out there for the *Hope*?

Hewlish drew a deep breath. "No. I can't get dispensat on You re lucky, be ng ret red and rich enough to ride your hobby."

They sat for a moment. Then Hewlish asked, Shall i program a drink?'

'Not for me, thanks You're not dr nk ng, either?'

"I don't like robot bartenders The customer has nothing to say I deve.oped a bartender that was v ab e a ong six categor es, but the chief ordered the brain for a po t cal un t "

They cont nued to sit At last Hewlish came to life. "There she is No there s someth ng d fferent—"

Captain Mack g anced at the satin gowned blonde who was approaching the refreshment area, grace fu y fending off dance bids He said, 'That's Siby "

"Have you met both girls?'

"Seen em, not met 'em On my last tran sit, before retired from the starsh p service They like to hunt in space. Spearing f sh in a barrel that s what it s '

Siby, approached their table Both men rose She smi ed "Capta n Mack? And th s must be Hew sh Are you wa ting for Roxanne?"

The three sat down, and S by cont nued, "Roxanne wouldn't come She says she has to get up early and sail. Rid cu ous sn t it?

Captain Mack growled, "So you're hunting a one "

S by shrugged angu d y ought to be it s no fun without Roxanne 'm rather sad, really Tw ns sometimes are on y half-people when they re alone '

"You and Roxanne will have to take separate paths when you mate," Hew sh said by way of rejoinder

Oh I never think of it Roxanne keeps reminding me, I'm bored with hunting, but I really don t want a change '

"A change from what? What are you? Hew sh asked

'I don t know What are you—I mean,

He programmed pancakes and waffles and scarcely tasted his dinner, so bewitched was he by her childish glee over the pancakes and jam

when you're not sailing?'

"My job is to develop increas ng y com p cated robots. I sail to use my human musc es and skills to know uncertainty dec sions, fatigue "

"What horrid things to know! And you must be very clever otherwise, making robots You make me feel so stupid Memorizing all those category responses!

"Ga act c know edge now encompasses several classes of what, for a l pract ca purposes, are infinities No s ng e master computer can do the sorting and reass gn ng The human bra n is st the most economical computer The least it can do s the preliminary index ng What s so diff cult about responding to An ma Vegetab e, Mine a ?'

Because I never can remember how to program for f sh or birds, or flyovers or hats, or why a r water and transportat on are Mine a "

The log c s very sound Is air Animal? Or Vegetable?"

"But I m not ogical."

"Of course you are Every human being is logica "

Oh, dear me Hewlish no!" S by aughed, in ght mus ca tones that charmed more than her gown " loathe boats and robots, yet I m amus ng myself at a ba with a sa ng capta n and an expert robotist '

"Would you ke to dance?" Hew sh sug gested

"Oh, yes, if you'd be so k nd just one dance before return to Roxanne '

The coup e rose and oined the dancers wa ting for the next conf gurat on

"Young foo " Capta n Mack muttered "That's the ast I ll see of him ton ght

But Hewlish returned alone after the configurat on He sa d, 'Her he x cab was on standby at the flyover platform "

You didn t ask her to pa r?

"Wel , no. I couldn't, somehow She was grac ous but not nterested That is when we were dancing, thought she was interested and then decided she wasn t and then just wanted t me to stop because she was so ovely – and so fragrant and her vo ce was like mus c She s —"

Bewitching " Captain Mack comp eted the thought He stood up ve made my appearance. can go back to the tower and take off these confounded ceremonials "

Hew sh rose also Capta n Mack said "P enty of girls ready w ling and able

"Yes, but S by makes the whole routine seem routine "

When Capta n Mack and Hew sh arr ved at the *Terran Hope* the next morning, Roxanne was wa t ng n the cockpit She was wearing a black acket, thick black, gloves b ack waterproof trousers and boots and a c ose fitt ng b ack cap

"Do we sail the circ e?" she asked

'Today s race is to be from buoy to buoy through the channels " said Captain Mack, tighten ng the j bstay. "We take a look at the course

Roxanne watched them rig the sa s, wh ch fluttered and wh pped n the breeze

Back sa Cast off!"

Hew sh jumped to the pier released the bowline, and jumped back g v ng the boat a vigorous shove Capta n Mack continued to warp the boat out of the s ot w th the boat hook When she was clear, they hau ed the sa s over she caught the wind, and the hull p voted against the rudder

How marve ous!" Roxanne squealed No power un t needed at all

"The wind is power," Hew sh sa d 'Hu man muscles are power "

The *Hope* glided on even kee n the narrow channe s the breeze shifted d ed gusted again, and the boat tacked one way and then another

Roxanne said cr t ca y to Hew sh, who was hau ing the j b, " perce ve you sa l by the rule book, not by the boat.'

'What do you mean?"

"Always at the same moment you fol ow the ma nsail You don t fee what the boat wants to do."

You th nk you know better than do?"

"I th nk I sense the boat better "

"We won without you yesterday."

"You were sailing an open circle. In a channel the wind comes trickily. Give me the rope."

Captain Mack warned, "The boat is too light with only three aboard. She'll heel over when the wind freshens."

'Not completely over,' Roxanne answered. "I observed during the race yesterday that when the sails lay over, the wind spilled out and the boat righted."

Roxanne took the line in her gloved hands. Whether it was a new breeze or a quicker response, the *Hope* glided more easily.

After the last channel, when they were proceeding across the open sea, the rising wind came strongly and pulled the sail away from Roxanne.

'On the rail!' roared Captain Mack.

Hewlish took hold of the jib line, close-hauled the sail, and jumped to join Roxanne, who was clinging for dear life to the tilted rail.

"How exciting!" she chirped. "Much better than hunting."

Lower rail plowing a furrow of foam, they flew over the water and gained the lee of the mooring basin.

"Oh, I'm drenched!" Roxanne complained, capering attention. "And salt stung and sun inflamed! But I've never been happier." She sprang to the pier. "Thank you, Captain Mack. Remember what I told you, Hewlish."

She ran joyfully away.

Hewlish said to the skipper, "The nerve of her! She can't really handle a jib."

"Naturally she lacked muscle power."

"I mean, in the channel. It was just beginner's luck."

"She seems to have an intuition about boats."

"But sailing has definite physical laws."

"So has singing or playing an instrument."

"Captain, are you saying the girl sails better than I do?"

"No, Hewlish. Calm down, man."

"Roxanne is too slow changing tack. She continually plays the sail."

"Yes. Forget it."

"Do you want to replace me as jibman?"

"No, what's the matter with you?"

"Well, the boat did sail better. Maybe just the weight distribution when she moved forward to take the jib."

"Will you forget it? We've got a big race this afternoon."

"Sure, sure. It's just we—"

That afternoon Sibyl and Roxanne sank onto their cushions and programmed the channel regatta. Roxanne said, "Sibyl, you must be ready to dress and hie to the mooring basin. After the race Hewlish will need consolation."

"You're certain they'll lose?"

"Thanks to my newly discovered sailing talent, yes. I've shaken Hewlish's confidence and Captain Mack's confidence in him. At crucial moments they'll hesitate. That's the time for you to move in."

"He may turn to Captain Mack instead of to me."

"I'll come with you and divert Captain Mack."

"Even so"—Sibyl looked sulky—"Hewlish isn't treacherous."

"Does he bore you because he's not wealthy?"

"No. He's not wealthy because he doesn't prey on others. He's clever, yet honest.'

"Dear Sibyl, you're giving this young man much unaccustomed thought."

"Hewlish is incomplete and interesting. He'll be wealthy, in time. He'll sail better, in time. Who knows where his inventive mind will take him in time? His life journey makes him interesting. Later he'll be boring."

"All the more reason to hunt him now."

"Is it? When one sets out to shear a sheep, one chooses a full-grown beast with a thick coat, not a young lamb with little to give and an honest nature to be hurt."

"To me, Hewlish seemed stubborn and disagreeable."

"You upset and confused him."

"I set him up for you. Don't you want to console him?"

"I suppose I do. I don't want him to lose the final race tomorrow."

"Then come and watch the results of my handiwork today. I've never known you to be so difficult."

"Roxanne took the line. The Hope glided more easily. After the last channel, the wind pulled the sail away from Roxanne. "On the rail!" roared Captain Mack."

The *Terran Hope* made a good start in the race but somehow lost her speed. She fell off on the tacks and was sluggish around the buoys, and her flying dash to the finish pulled her only to a third place.

Hewlish was crestfallen and would not follow the rest of the crew ashore.

Captain Mack said, "Don't take it so hard. With a first and a third we're still leading. Tomorrow we'll win."

"It's the circle again. True, I'm more used to the circle."

"Of course you are. Come ashore—to the casino perhaps."

They secured the gear, adjusted the mooring lines, and stepped ashore.

Two familiar sun-cloaked figures greeted them. 'Ah, Captain Mack,' said Roxanne, "now you must walk the gardens with me and explain the race in detail. I shall scold you properly for losing the current at the second buoy."

'They set the buoy in the riptide. Whether from ignorance or development," said Captain Mack, 'we'd better not inquire," and he followed Roxanne.

Hewlish said to Sibyl, "May I escort you to your helix, or will you follow your sister?"

'Neither. I don't know what to do."

About what?"

"Roxanne. She's so mischievous.'

Mischievous, indeed! I wish she had never come aboard. Let me tell you—"

Sibyl glanced around uncertainly. 'Must we talk standing here?

No—that I may escort you to the pavilion?"

"Oh, yes. You must be hungry after the long sail."

"I'm disgusted with myself. I don't want to look at food."

"You'll have to, in the pavilion. Besides, you'll have to program for me. Food categories bewilder me."

They crossed a flower-bordered lawn and entered the pavilion. The robot maître d'hôtel flipped the number 33, and the number over a corresponding table lit up.

"Oh, I'd prefer a window table," Sibyl said.

'The robot is programmed for the convenience of the serving wagons.'

Let's step aside then. Others can take the middle tables.'

Hewlish looked curiously at Sibyl. Do you often circumvent robots?"

"Doesn't everyone? Step aside, Hewlish, and let this other couple have the table."

Hewlish stepped aside. One after another he bowed four couples ahead of them, until a window table lit up and Sibyl swept triumphantly past the robot maître d'hotel.

As they seated themselves Sibyl said, "Program for me, dear Hewlish."

Sibyl, the food categories are simple. Breakfast, Lunch, Tea, Dinner." He reached to the center of the table and turned the order unit toward them. 'Which would you like?

"Tea, but I want pancakes."

Pancakes are a Breakfast category."

"No. Breakfast pancakes have syrup. I want pancakes with jam."

'With Tea you can have waffles with jam.

"But I want pancakes. Sometimes Roxanne and I program both Breakfast and Tea, and I use her jam pot with my pancakes. But she really doesn't like my syrup on her waffles."

"Discard the waffles and syrup."

"Well, yes, but food wasting is the worst crime in the galaxy. I'd be arrested if I left food in a public place."

"Are you hinting that I should eat the waffles and syrup?"

'Would you, dear Hewlish?"

No. I would not. What a selfish question!

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Originally this world is just a desert, an arid, the size of Maine.

THE UNGREENING

BY KENNETH BROWER

Reclaiming the desert is an old human dream, but it is easier dreamed than done. Weather modification is the desert reclamation fantasy that dies hard. There have been proposals for a Saharan Inland Sea that would change the climate over our greatest desert. The ecological wisdom of such a gargantuan project is more than doubtful, and the technical feasibility falls apart under close scrutiny. Cloud seeding, of dubious worth anywhere, is especially [illegible] water-bearing clouds

PHOTOGRAPH BY ERIC MEOLA

exist to be seeded: no clouds, no rain.

Much of our progress against deserts is illusory. In a recent *National Geographic*, a striking double-spread photograph depicts the 80-hectare estate and private golf course of publisher Walter Annenberg. It is a modern oasis of vibrant green against the pale sands of the desert around Palm Springs. This kind of reclamation is just sleight of hand. The greening of Palm Springs and the rest of southern California is achieved by the browning of former farmland and ranchland in places like Owens Valley and the Mono Basin, which had to give up their water to quench the thirst of Greater Los Angeles. Private golf courses in the dry half of California are kept up at the expense of little people in the wetter half of the state. We do reclaim deserts. But the arm that reclaims them is Woody Allen's. The arm that makes them is Arnold Schwarzenegger's.

His mind searched for something tall in that landscape. But there was no persuading tallness out of heat addled air and that horizon: no bloom or gently shaken thing to mark the passage of a breeze . . . only dunes and that distant cliff beneath a sky of burnished silver-blue.

More often than is good for us, time makes prophets of our science-fiction writers. Frank Herbert, author of *Dune* and imaginer of the heat-addled landscape above, may soon join that prescient company. We are building Arrakis. Dune, Herbert's desert planet, right here on the blue-green planet Earth. Ecologists call the process desertification. The process is accelerating. To an extraterrestrial astronomer it would manifest itself as a gradual paling, a shift to tawniness in the mysterious green zones of the planet's middle latitudes.

The newcomer to Arrakis frequently underestimates the importance of water here,' says Dr. Kynes in Dune. 'You are dealing, you see, with the Law of the Minimum.

He might as well have been speaking of Earth. About a third of this planet's land area, 48 million square kilometers, is arid or semiarid. Dry-land ecosystems are particularly fragile. There is too little water, too much solar energy for life ever to become truly comfortable.

Thirty million square kilometers—19 percent of the earth's land surface—is threatened by desertification. Man-made deserts already occupy a region larger than Brazil. Annually this world loses to desert an area nearly the size of Maine. In Sudan, Africa, the southern edge of the Sahara is marching south at the rate of 6 kilometers a year, and in places its advance is 100 kilometers south of where it was 17 years ago. Other deserts are spreading in southern Africa, in Australia, in both Americas, and in the Middle East and elsewhere in Asia. At the present rate of degradation, we will lose one third of the planet's arable land by the end of this century. One sixth of mankind, 600 million to

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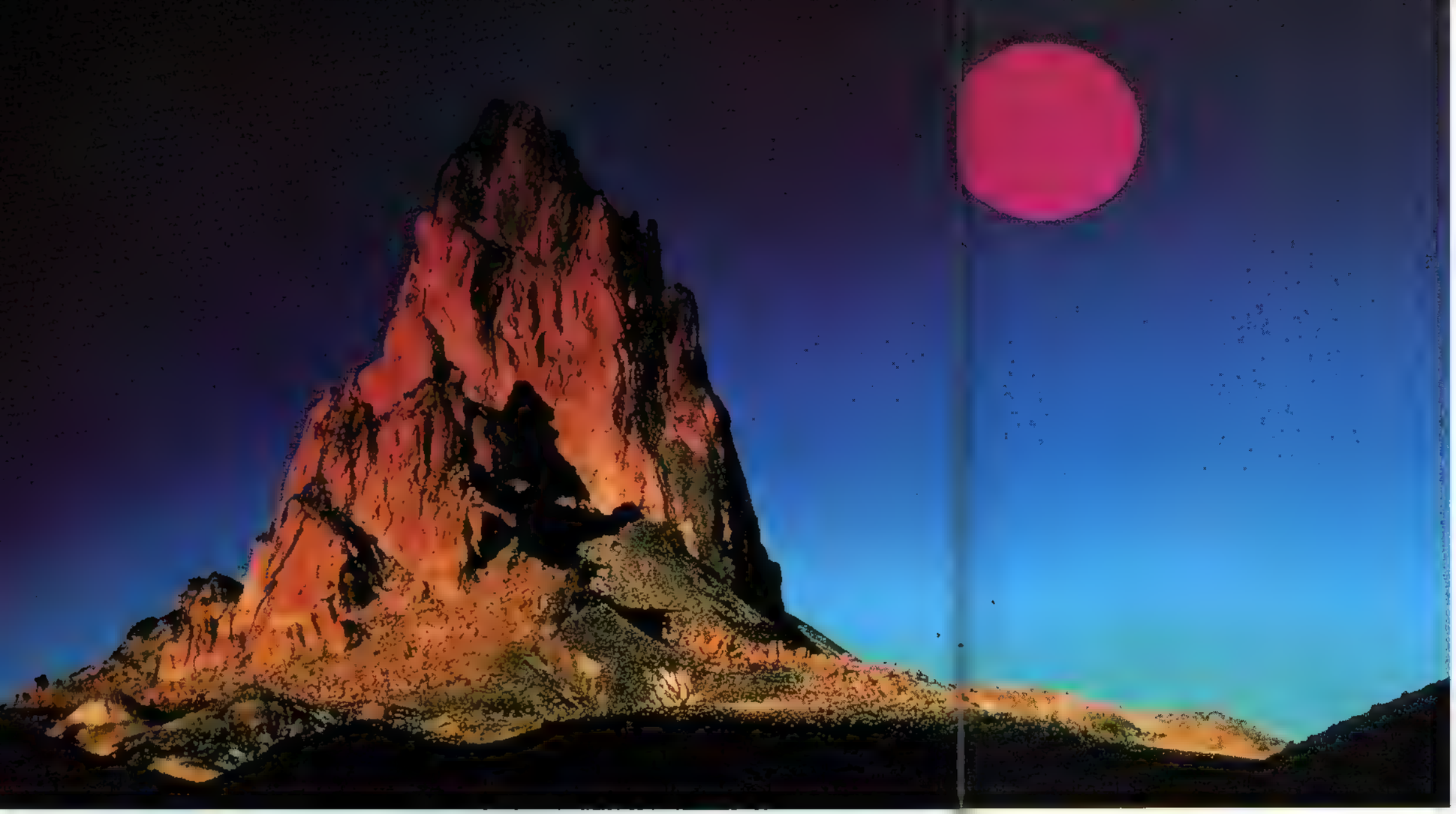
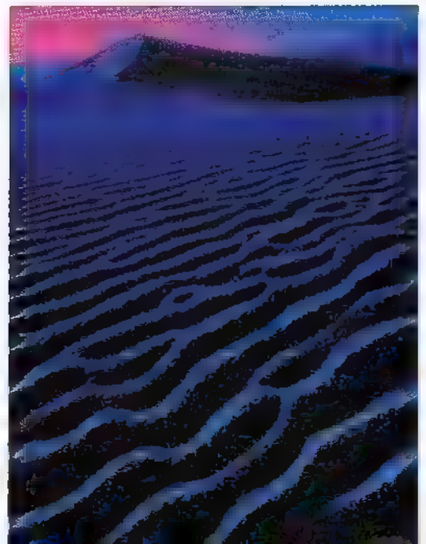




TERRAFORMS

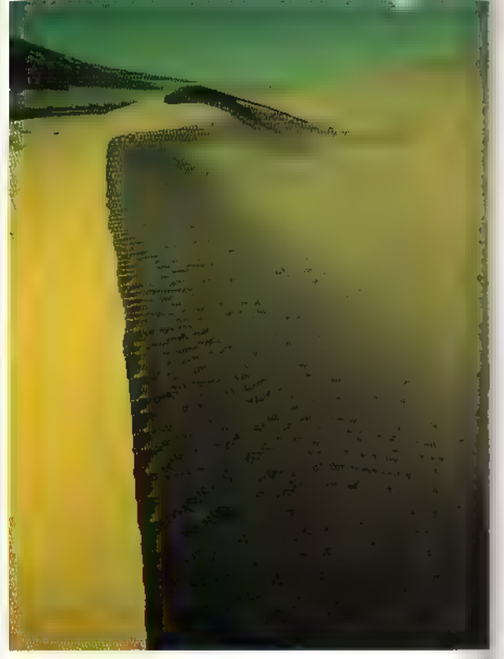
BY RICHARD LEVITT

Relentless wind, volcanic upheavals, and primordial seas carve the land into sensual, contoured shapes

PHOTOGRAPHS BY DAN MORRILL

Traversing the proverbial burning wastelands beneath a relentless desert sun, one is struck by the apparent absence of life and stunned by the accumulated silence of the ages. The desert has none of the lushness of high mountain forests with aromatic meadows and fresh, clear waters. This is harsh country. Stripped clean of soil and vegetation, the stone has been chiseled into a work of natural art. Over the tens of millions of years, great inland seas, flowing rivers, and the wind's cutting edge of dust and sand wore away the strata, producing jagged spires, lofty dunes, and flat-topped mesas. The desert is a land of tremendous distances, scorching heat, bitter cold. For Chicago-bred photographer Dan Morrill, this tortured landscape is the purest of places, testimony to the cataclysmic upheavals of a distant geological time. But beyond everything else, there are stark shapes everywhere.

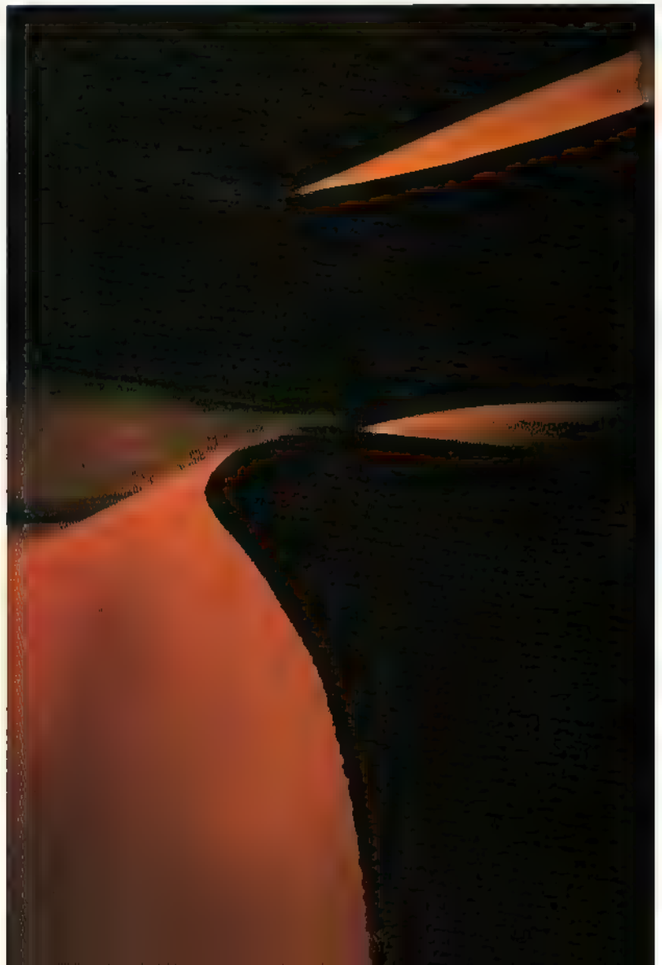
"Rocks are holy," say the local Indians. A mass of lava rock, rising more than 425 meters above a New Mexico plain, once churned within the caldron of a

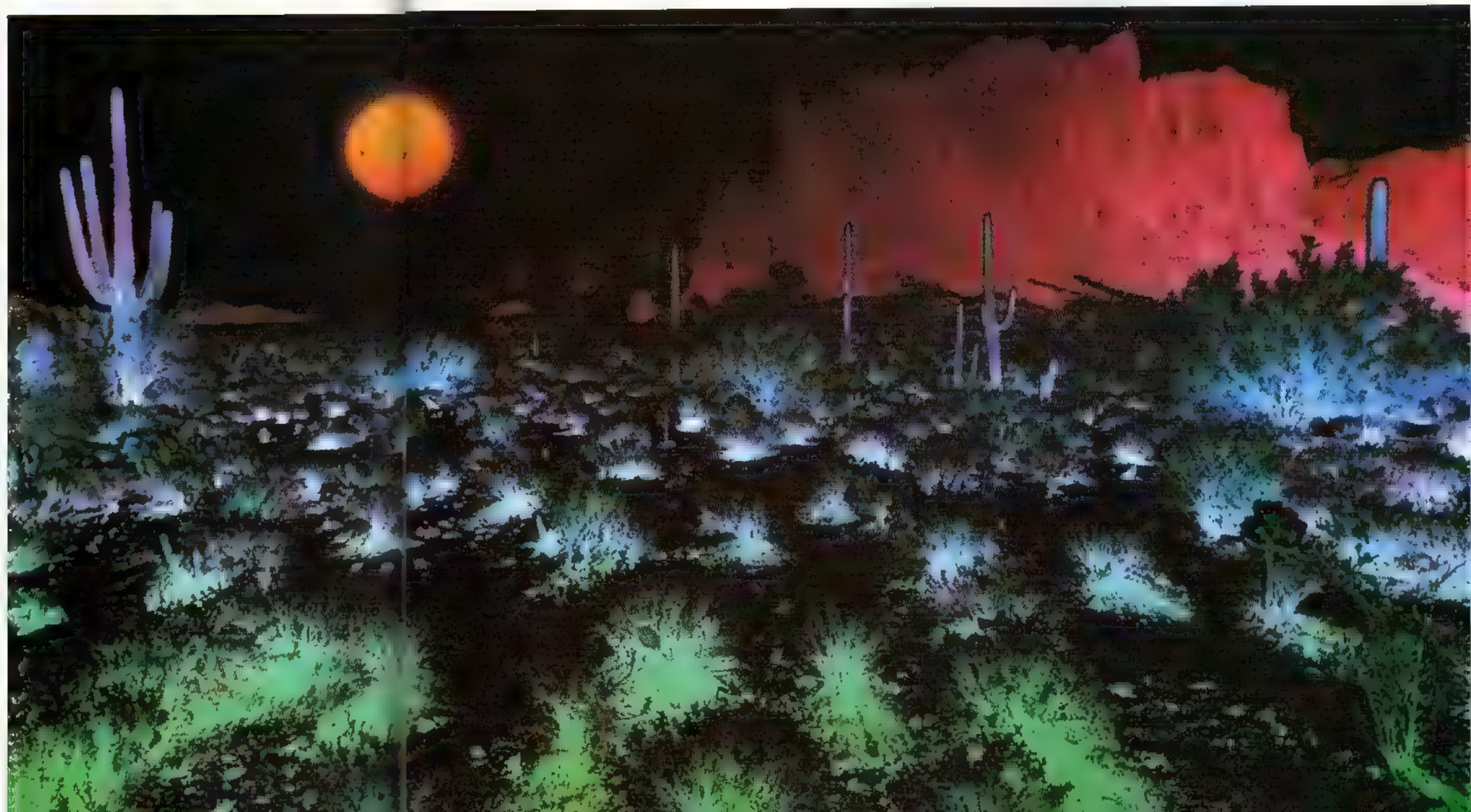


"The desert is a forbidding and wild place, but all its parts are harmonious."

volcano that has vanished. The cone was eroded to nothingness by nature's hand work. Farther west in California's Mojave Desert, winds ripple low-lying sands, gathering up fine grains to make huge dunes that resemble snowdrifts. The slanting rays of the sun create shadows that intensify dune contours, emphasizing the knife-like sharpness of the ridges. Bathed in moonlight, cloudlike sand plumes rise above ridges that curl into downward slopes, forming fresh intricate patterns. A forest of saguaro cactus in Arizona's Superstition Mountains assumes grotesque and eerie form when captured on infrared film. These saguaros weigh as much as seven tons and grow as tall as 15 meters. It has been calculated that only one out of several million saguaro seeds survives to produce a single plant. Sandstone sculptures like the ruins of a Greek temple stand in isolation near the California-Nevada border. Soaring 60 meters into the sky, the stone minarets were carved by wind and water to form their distinctive shape.

One of the world's foremost experts on deserts, Egyptian geologist Farouk El-Baz notes, "There is a general lack of knowledge about





"At first glance, the land is seemingly empty and barren, almost lifeless."

deserts that has led international agencies and underdeveloped countries to continue spending vast sums on often-fruitless programs to combat desertification." El-Baz feels that the present time is especially ripe for in-depth studies because of developments in satellite photography.

Reclamation is only one aspect of desert management now under way in Egypt. Special communities are being built in the desert to promote industry and boost productivity. Other studies have shown that certain desert flora, including buffalo gourd, jojoba, and guayule plants, are sources of oils and rubber, which might lessen U.S. dependence on imports. About 5 million barrels of oil per day could be extracted from gumweed harvested in the Nevada desert at $20 a barrel. One study has shown that ten barrels of high-grade oil could be extracted from one hectare of desert.

None of these projects will bear fruit if mankind continues his unrelenting assault on the desert's fragile ecosystem. Like any natural environment, a desert must be protected from the blight of modernization. ∞

A few important genes located on a single chromosome may hold the secret to aging and life extension

SUPERGENE

BY KATHLEEN STEIN

'Aging, my guess is," declares R chard Cutler, one of the most nventive minds in life-extension research, "is the relaxation of the cell's capacity to maintain its proper state of differentiation. The cells do their thing for a specific time and then slowly drift away," he says. 'Nerve cells aren't quite the same anymore, they become more ike kidney or liver cells, a different *thing*. And then they randomly drift away from their original stringent gene-control state." Loss of differentiation, Cutler has shown, happens to some cells when they age.

For the last 15 years Cutler, like a detective, has been tracking the subtle and complex interplay of biochemical processes that enable us to live longer, healthier lives. He suspects that lengthening a human life might not be such a complex thing to accomplish. "The comparatively recent doubl ng of the human life span since the time man started walking erect," the gerontologist observes, 'required relatively few genetic changes." These mutations may constitute as little as 0.6 percent of the human genome, or set of chromosomes.

n his highly personalized vocabu ary Cutler attributes much of the "rapid' increase in early man's longevity to the development of "longevity-determinant processes," which protect the body s cells from internal and external aging processes. These mechanisms keep the organism in shape the same way "a maintenance shop' does.

Many people think that because you study the aging process, you re trying to determine what causes ag ng," Cutler explained last summer, en route to the Gordon Conference, a yearly affa r where gerontologists meet pr vately to compare notes. "And once you find out, you'll try to get rid of it, to invent some means of cleaning it up.

'What I m saying is completely nove and I don t think it's widely appreciated yet. There may be

PAINTING BY WILSON McCLEAN

relatively few genes whose sole purpose is to govern the duration of good health which is the same as govern ng aging rates."

Another highly reputable investigator, Roy Walford, meanwhile had been gathering evidence suggesting that these few genes are regulated from a location on the sixth chromosome in humans—a family of genes with a name as weighty as its functions—the major histocompatibility complex (MHC). Since 1970 Walford of UCLA's Medical Center, has approached the gene family from an immunologist's point of view. He had seen it as a trouble spot and had presented powerful arguments implying that problems in the MHC could cause aging and death. He proposed that many diseases associated with aging could be accounted for by mutations of the MHC, which lead to dysfunctions of the immune system. "This collection of genes is a kind of master control region for the immune system," he asserted. "It's fundamentally involved in the aging process."

Packed within the nucleus of the cell enormously long strands of DNA are backfolded upon themselves as much as 18 000 times. Helixes wind around helixes until they coil into solenoid springs of incredible potential energy. If you were to pull on a coil like a telephone cord, you would feel the tension: the twist and resistance of the double strands left to go and it would writhe back to its tightly coiled configuration.

These superhelixes, as the coils are called, compose both the architecture and the workers in the corporate headquarters of the supergene systems, megaplex conglomerates of gene families regulated from or located within, single chromosomes. Such corporations mastermind life. Together they build tissues, synthesize hormones, and regulate metabolism.

During the last several years scientists have accumulated evidence that one of these supergenes may be involved in the regulation of the human life span. Such gerontologists as Walford and Cutler have traced many of the mechanisms that may determine aging and longevity to one location in one chromosome, the major histocompatibility complex. Before anyone else, Walford had said that the MHC is one of the regulatory supergenes controlling aging.

If the regulatory genes of the MHC work closely together are inherited together and are placed together it may be possible to control them together. It may turn out that there is indeed a longevity determining supergene," says Cutler. "What this ultimately means is that we'd better identify those regulatory processes and learn to enhance their expression, and then we might postpone the whole spectrum of aging."

With the gene splicing techniques employed today to modify animals' heredity the next step could be to implant this 'regulatory" supergene into a mammal's egg cell and perhaps create a super long-lived mouse—or man. The MHC gene cluster may hold many answers to the questions facing gerontologists at the threshold of the most formidable of breakthroughs.

In 1972 Cutler predicted that longer lived species should be found to have correspondingly higher levels of genetic repair. Evidence of this was found within two years. One might say the recent history of genetic gerontology really began in 1974 with a paper by Ron Hart and Richard Setlow entitled "Correlations between deoxyribonucleic acid excision repair and lifespan in a number of mammalian species." DNA repair. What a marvelously efficient custodial process! It protects genes from radiation, toxic chemicals, and damaging metabolic by-products.

When DNA is damaged the genes can no longer govern the cell. The DNA then will miscode information, or not code at all. The cell begins to malfunction and eventually dies. Multiply this by millions of cells in the brain, say, and you get a brain that's mush. Synapses don't fire, hormone levels don't balance throughout the body, senility strokes the big sleep.

> *"Scientists may be very close to manipulating life span. We're trained to understand the mechanisms, not the impact these discoveries will have on society."*

Hart, now working at the Food and Drug Administration, says, "DNA damage occurs and reaches a threshold of tolerance, and then death follows. During damage accumulation, senescence results. An example: "Ultraviolet radiation, the primary target of which is DNA, causes accelerated aging of the skin."

DNA is repaired by enzymes such as the endonucleases, which cut out damaged segments the way plumbers remove sections of broken pipelines. The missing segments are then filled in or patched through the enzymatic action of polymerases that resynthesize new DNA.

Hart and Setlow were the first to demonstrate a positive correlation between DNA repair and maximum life span in a number of animals: everything from long-tailed shrews to Indian elephants to humans. Generally speaking, long lived species exhibit more DNA repair than short-lived species: humans having the most.

Late in 1979 Dr. Joan Smith Sonneborn electrified the gerontological community with her elegant experiment enhancing DNA repair in *Paramecium*. The dynamic protozoologist from the University of Wyoming demonstrated that the maximum life span of one-celled animals can be significantly extended through trickery. First she exposed the paramecia to ultraviolet (UV) radiation damaging their DNA. Then she removed the damage by stimulating 'photoreactivation' (PR) repair enzymes with short-wavelength visible light. The UV/photoreactivated animals lived almost a third longer than normal. Smith-Sonneborn inferred that "ultraviolet [damage] induces a DNA repair process, and photoreactivation corrects the UV-induced damage, freeing the repair mechanisms to correct age damage."

It was as if the U.S. Army Corps of Engineers had been "induced" by an alarm that the Golden Gate Bridge was splitting in two. The engineers marched out only to find that the bridge had already been fixed by the local repair crews. But as long as they were on the scene they decided to do some maintenance, tighten up some cables, replace some rivets, and so on, increasing the life span of the structure.

Although Smith-Sonneborn can't yet use her UV/PR technique on people, she nevertheless has accomplished something truly important. For the first time it was demonstrated that extra protection or repair can be induced in an animal, and these results imply that increased repair can extend life. Since then Smith-Sonneborn has collaborated with Philip Lipetz, who studied with Hart and who continues to investigate DNA structure at what was once Hart's damage-and-repair shop at Ohio State University. Lipetz, a superhelicity specialist, wanted to know what caused DNA supercoilicity to become altered in aged cells. Smith-Sonneborn wanted to find out what mechanisms could control DNA repair in her protozoa.

Joan's system was beautiful for measuring the interrelationship between DNA repair, aging, and superhelicity," Lipetz reported. "We're getting at the molecular mechanism controlling not only DNA repair of UV-induced DNA damage but perhaps other basic molecular mechanisms of aging." He grimaced at the image of the genetic strategy superhelixes like molecular accordions, but he admitted that as scientists continue to find out how enzymes control the supercoils they might keep the DNA looped or relaxed at will, to facilitate repair and protective processes. "Yeah, that's the direction Joan and I are taking. I don't know what form the treatment will take, but it wouldn't surprise me if it were accomplished next year. It wouldn't surprise me if it took longer either."

In the meantime immunologist Walford with his colleague Kathleen Hall was gathering exciting evidence that DNA repair processes were linked to the MHC supergene locus. Examining the spleen cells of inbred mice, he found a direct correlation between DNA repair and maximum life span. He studied mice that were genetically "identical" except for one region—the major histocompatibility complex area.

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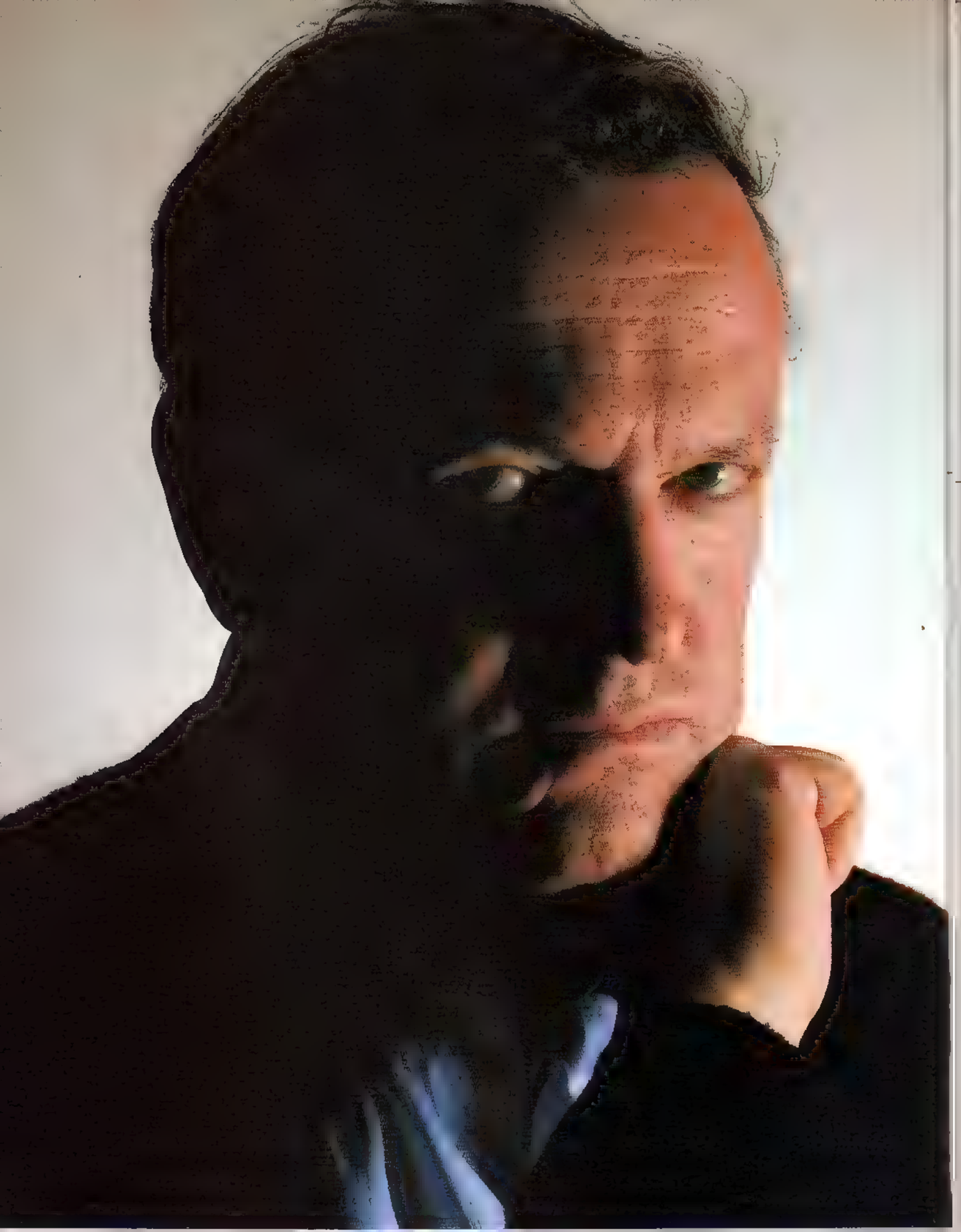


The maverick astrophysicist who explained pulsars and moon dust now has a cure for the energy crunch—and it's lying right beneath our feet

INTERVIEW

THOMAS GOLD

Photographs by Michael Somoroff

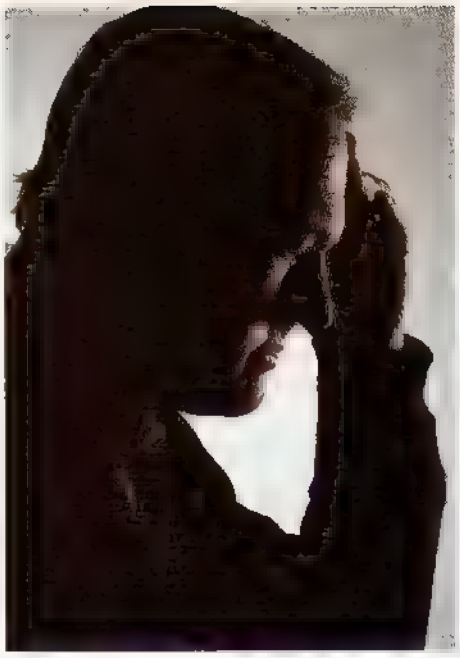
Nothing Tom Gold says ever passes smoothly through the scientific community. His name is associated as much with challenge, outrage, and cries of "I told you so!" as it is with hard work and belated recognition.

When a tough question in cosmology arises or a newly discovered phenomenon cannot be understood, Gold is among the first to offer an explanation. Figuring out the physical forces that make the world work is, he says, what he's good at. He has put his formidable mind to the electroacoustical system of the inner ear, the plasma physics of solar outbursts, the stability of Earth's axis of rotation, planetary physics, celestial mechanics, and more. Usually his unorthodox ideas hold at least a kernel of truth. To people who oppose his views, he writes humorous short verse, or long letters in the scientific literature, or both.

Gold argued passionately in the 1950s that the surface of the moon was covered with a fluffy dust that would swallow any spacecraft trying to land there. "Gold dust," as it came to be called by astronomers who disagreed with him, turned out to have more the consistency of a sandy beach than of a fine powder, but existed. It did. The moon did not have a rock smooth floor. And years later, when Apollo astronaut (now U.S. senator) Harrison Schmitt exclaimed to Earth that he'd stumbled on a field of orange glass of apparently recent origin, Gold fired off a letter to the *New York Times*, promising that the orange glass would be found to be just as old as the rest of the moon. Months later analysis of the material proved him right.

With Sir Hermann Bondi and Sir Fred Hoyle, Gold developed the steady-state theory of cosmology, which postulates the continuous creation of new matter in empty space, so that as the universe expands, its density remains everywhere the same. The idea is not as popular as the big-bang theory favored by most astrophysicists, but Gold remains committed to it in principle, saying it makes an excellent model against which to compare observations.

While the cosmological question may never be resolved in his



"I believe there's methane in deep layers on the earth and that what is down there is far more abundant than all the oil ever found."

lifetime more testable problems have earned Gold the respect of his peers.

In 1967, when Gold arrived first at the correct explanation of how and why pulsars emit their regular bursts of radio noise from deep space, the prevailing wisdom was so heavily turned against him, he recalls, that he was barred from expressing his views at a scientific symposium on the subject. Before year's end, however, subsequent discoveries supported his hypothesis and convinced the opposition.

Like the concurrence of his fellows, his doctoral degree also came to him belatedly. Born in Vienna in 1920, Gold started his scientific career in England during World War II, designing radar devices for the Royal Navy. He is credited with helping to develop the technology that made possible the detection of hidden aircraft and submarines. The war interrupted his studies at Cambridge University, which finally awarded him his doctorate in 1969, ten years after he'd been appointed chairman of the astronomy department at Cornell University, in Ithaca, New York. After the war, Gold settled in Cambridge as a researcher in the famed Cavendish Laboratory, where he built large magnetrons for accelerators.

At Cornell today, Gold is director of the Interdisciplinary Center for Radiophysics and Space Research, which he established, and is the John L. Wetherill Professor of Astronomy. He has taught astronomy at Harvard, served as visiting professor at the Royal Observatory, and is a member of both the Royal Society of London and the National Academy of Sciences. He has also served on the President's Space Sciences Committee and on senior committees for NASA.

Reminiscing about his long acquaintance with Gold, John Maddox, editor of *Nature*, said he sat next to "Tommy" at a symposium nearly 30 years ago, where "somebody was trying to argue that there was no point in looking for living things elsewhere in the solar system, for there were no signs on other planets of the living things that we know on the surface of the earth. 'What a fool!' Gold sputtered. They might look like rocks, not people!' "

True. Gold's thoughts have ranged over every conceivable extraterrestrial question, but his current battle, which he discussed at length with writer Dava Sobel, involves physical processes right here on Earth and may prove to be his most widely appreciated contribution. After years of studying the derivation of the volatiles (substances that were once part of a gas) on planetary surfaces, Gold is prepared to argue that large quantities of hydrocarbon gases, seeping out of Earth rocks over millennia, account for much of the surface carbon seen today. Moreover, the outgassing explains critical features of earthquakes, might even help predict them, and offers a possible source of energy so vast, he says, that "the entire fuel crisis will soon be a thing of the past."

***Omni*:** What controversial issue has most captured your imagination recently?

Gold: Energy. I believe that methane—natural gas—is present in deeper layers of the earth in very large amounts and that it's this methane oozing out gradually that has supplied much of the carbon on the surface. The conventional belief is that the carbon came up as carbon dioxide, which would be of no interest for energy. But if a substantial amount seeped out as methane, then there is probably some still down there, and we'd be talking about vastly greater quantities of combustible fuel than all the oil that's ever been found on the planet. At the same time we have an energy crisis because geologists go around saying, 'We think there isn't any more oil or gas to be found on the earth."

***Omni*:** Has the government done anything to explore the methane possibility?

Gold: So far, nothing. It isn't that there's a real fuel shortage at this time, only a prediction of a shortage, and the public and the politicians don't seem to understand how weak the evidence is that it's based on. The government just swallows this information, yet the fates of many nations and of the whole world economy are dependent on the prediction that fuel is running out. A large-scale public inquiry now would expose the uncertainties, and that by itself would depress the fuel price. But the government doesn't take my theory seriously, even though I've assembled a great deal of evidence; the government seems to believe a new theory should be a hundred percent certain before any action is taken."

***Omni*:** Where do you think the untapped methane might be found?

Gold: In very convenient regions, but at considerable depths. Gas needs to be sealed by a tighter cap than oil does, and so it tends to be found deeper down, where there are more tightly packed layers. Very little of the earth has been investigated down to, say, four thousand meters, where the gas is more likely to be. I believe methane will be found at such depths in many areas.

We should begin by searching where we'd most like the gas to be. New England, for example, is very short of fuel. California is a good prospect. There the oil is shallower, but one has not looked very seriously deeper down for gas. If you want gas in a certain city, then search first in the vicinity of that city. In many areas it might turn out much like drilling for water: you build a house and drill there in the first place—except that you'll have to drill to four thousand or five thousand or even seven thousand meters for methane.

***Omni*:** Do you predict that this supply of methane will be a more plentiful source of energy than the sun?

Gold: Of harnessed energy, yes. People are just passionate about solar energy. It would be so nice! And I agree that it would be so nice, but if you were to cover Arizona with solar cells, dust them off once a week and do all that it takes, you're still talking

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FICTION

Mission completed, the Wreckers were poised to land and rebuild on the ruins of their old world

ST. AMY'S TALE

BY ORSON SCOTT CARD

Mother could kill with her hands. Father could fly. These are miracles. But they were not miracles then. Mother Elouise taught me that there were no miracles then.

I am the child of Wreckers, born while the angel was in them. This is why I am called Saint Amy, though I perceive nothing in me that should make me holier than any other old woman. Yet Mother Elouise denied the angel in her, too, and it was no less there.

Sift your fingers through the soil, all you who read my words. Take your spades of iron and your picks of stone. Dig deep. You will find no ancient works of man hidden there. For the Wreckers passed through the world and all the vanity was consumed in fire; all the pride broke in pieces when it was smitten by God's shining hand.

Elouise leaned on the rim of the computer keyboard. All around her the machinery was alive, the screens displaying information rapidly, as if they knew they were the last of the machines and this the last of the information. Elouise felt nothing but weariness. She was leaning because, for a moment, she had felt a frightening vertigo. As if the world underneath the airplane had dissolved and slipped away into a rapidly receding star and she would never be able to land.

True enough, she thought. *I'll never be able to land, not in the world I knew.*

"Getting sentimental about the old computers?"

Elouise, startled, turned in her chair and faced her husband, Charlie. At that moment the airplane lurched, but, like sailors accustomed to the shifting of the sea, they adjusted unconsciously and did not notice the imbalance.

"Is it noon already?" she asked.

"It's the moral equivalent of noon. I'm too tired to fly this thing anymore, and

PAINTING BY EVELYN TAYLOR

t s a good thing Bill's at the controls."

"Hungry?"

Charl e shook h s head. "But Amy prob ab y is," he said.

"Voyeur," said E ouise.

Charlie l ked to watch E ouise nurse the r daughter. But desp te her accusation E ouise knew there was nothing sexual in it. Charl e l ked the idea of E ouise be ng Amy's mother. He liked the way Amy's suck-ng resembled the sucking of a calf or a amb or a puppy. He had said, "It's the best thing we kept from the an mals. The best th ng we d d n't throw away."

"Better than sex?" E ouise had asked. And Charlie had only sm led.

Amy was playing with a rag doll n the only l arge c ear space in the a rp ane near the ex t door. "Mommy. Mommy. Mamommy. Mommy-o," Amy said. The ch d stood and reached to be picked up. Then she saw Charl e. "Daddy. Addy. Addy."

"H ," Charl e said.

"H ," Amy answered. "Ha-ee." She had only just l earned to close the diphthong, and she exaggerated it. Amy p ayed w th the buttons on E ouise's sh rt, try ng to und o them.

"Greedy," E ouise sa d, laugh ng.

Charlie unbuttoned the shirt for her and Amy seized on the n pp e after only one false grab. She sucked nois y, tapping her hand gently aga nst E ouise's breast as she ate.

"I'm g ad we re so near finished," E ouise said. "She s too o d to be nursing now."

"That's r ght. Throw the itt e bird out of the nest."

"Go to bed," E ouise said.

Amy recognized the phrase. She pulled away. "La-o," she sa d.

"That s r ght. Daddy's go ng to s eep," E ou se sa d.

E ouise watched as Charlie stripped off most of his clothing and l ay down on the pad. He smiled once, then turned over, and was immed ate y asleep. He was in tune w th his body. E ou se knew that he wou d awaken n exactly six hours, when t was time for him to take the controls again.

Amy's suck ng was a subt e pleasure now, though it had been agonizing the f rst few months, and painfu aga n when Amy's first teeth had come in, and she had learned to her delight that by nipping she could make her mother scream. But better to nurse her than ever have her eat the pre digested pap that was served as food on the airplane. E ouise thought wryly that t was even worse than the m crowaved veal cordon bleu that they used to inf ct on commercia passengers. Only e ght years ago. And they had cal brated their fue so exactly that when they took the last draft of fue from the last of their storage tanks, the tank registered empty, they would burn the last of the processed petro eum, nstead of putt ng t back into the earth. Al their caches were gone now, and they would be at the tender merc es of the world that they themselves had created.

Still there was work to do. The f nal work, the f na checks. E ouise he d Amy with one arm wh e she used her free hand slow y to key in the l ast program that her role as commander required her to use. E ouise Pr vate, she typed. Teacher, teacher. I de c are I see someone's underwear, she typed. On the screen appeared the warn-ng she had put there. "You may think you're lucky finding this program, but unless you know the magic words, an a arm is going to go off all over this a rplane and you'll be had. No way out of t, sucker. Love, E ou se."

E ouise, of course, knew the magic words. E nste n sucks, she typed. The screen went b ank, and the alarm did not go off.

Ma funct on? she queried. "None," an-swered the computer.

Tamper? she quer ed, and the computer answered, "None."

Nonreport? she quer ed, and the com puter flashed, "AFscanP7bb55."

E ouise had not rea y been doz ng. But st ll she was start ed, and she l nched for

"Did his hands tremble as he touched the controls? Elouise watched very carefully, but he did not tremble. Indeed, he was the only one who did not. Ugly-Bugly started to cry."

ward d sturb ng Amy, who really had fal en asleep. "No no no," said Amy, and E ouise forced herself to be patient. She soothed her da ghter back to s eep before pursu ing whatever t was that her guardian pro gram had caught. Whatever 't was? Oh, she knew what it was. t was treachery. The one thing she had been sure *her* group, *her* airplane would never have. Other groups of Rectif ers—Wreckers, they called them-selves, having adopted the r enemies' name for them—other groups had had the r spies or their fa nthearts, but not B ll or Heather or Ugly Bug y.

Spec fy, she typed.

The computer was specif c.

Over northern V rgin a, as the airplane fo owed ts careful route to find and destroy everyth ng made of meta , glass, and p astic, somewhere over northern V rg nia, the airplane s path bent sl ghtly to the south, and on the return, at the same p ace, the airplane s path bent slight y to the north, so that a str p of northern Virginia two kilometers long and a few dozen meters wide could contain some nonbiodegradab e art fact, hidden from the a rplane, and if E ouise had not quened th s program she wou d never have known it.

But she shou d have known it. When the plane's course bent, alarms should have sounded. Someone had penetrated the f rst ne of defense. But B ll cou d not have done that, nor cou d Heather really—they d d n't have the sophisticat on to break up a bubb e program. Ug y-Bugly?

She knew it wasn't faithfu o d Ugly-Bugly. No, not her.

The computer voluntarily f ashed, "Over-ride M577b commandmo4, intw s CtTttT." It was an apo ogy. Someone aboard sh p had found the a arm override program and the overrides for the a arm for improper use of the a arm overrides. Not my fau t, the computer was say ng.

E ou se hesitated for a moment. She looked down at her da ghter and moved a cur of red ha r away from Amy's eye. E ou se's hand trembl ed. But she was a woman of ice, yes a frozen where com-passion made other women warm. She pr ded herse f on that on hav ng frozen the last warm places in her—frozen so god-damn rigid that it was only a moment's hes tation. And then she reached out and asked for the access code used to perform the treachery, asked for the name of the tra tor.

The computer was even less compas-sionate than E ouise. It hes tated not at al .

The computer d d not underline, the let ters on the screen were no larger than nor mal. Yet E ou se fe t the words as a shout, and she answered them s lent y w th a scream.

Char es Evan Hardy, b24ag61-r ch and, WA.

t was Charl e who was the traitor. Charl e, her sweet, soft hard bod ed hus band. Charl e who secretly was try ng to und o the end of the wor d.

God has destroyed the world before. Once n a flood, when Noah rode t out n the Ark. And once the tower of the wor d s pr de was destroyed in the confusion of tongues. The other t mes, f there were any other t mes, those t mes are all forgotten.

The wor d w ll probab y be destroyed aga n, un ess we repent. And don't think you can hide from the angels. They start out as ordinary people, and you never know which ones. Sudden y God puts the power of destruction n their hands, and they de-stroy. And just as suddenly, when a the destruct on is done, the angel leaves them, and they're ord nary peop e. Just my mother and my father.

I can t remember Father Charl e's face. I was too young.

Mother E ouise to d me often about Fa-ther Charl e. He was born far to the west n a and where water on y comes to the crops in ditches, almost never from the sky. It was a land unb essed by God. Men l ved there, they be eved only by the strength of their own hands. Men made the r d tches and forgot about God and became scient sts. Father Charl e became a sc ent st. He worked on t ny anima s, breaking the r

CONTINUED ON PAGE 116

MOONSTRUCK!

BY BEN BOVA

HERE MEN FROM THE PLANET EARTH
FIRST SET FOOT UPON THE MOON
JULY 1969 A D
WE CAME IN PEACE FOR ALL MANKIND

These words are inscribed on the ascent landing module of the *Apollo 11* spacecraft, *Eagle*, which waits for our return to the Sea of Tranquility.

We may never be back.

The last line of that inscription, that noble sentiment about "all mankind," may be the death knell for America's space program.

Ten years after we reached the moon, the United Nations General Assembly passed the so-called Moon Treaty. By August 1980, five nations had signed the treaty, putting it into effect for all the signatory nations. If the Moon Treaty is signed by the United States and ratified by the Senate, it could spell the end of any significant American or Western European space effort.

Officially the treaty is entitled Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. It is the most far-reaching international document ever written.

In the words of Arthur M. Dula, a Houston attorney who specializes in space law, "The Moon Treaty's provisions will control the activities of the United States, *as well as those of all U.S. citizens and organizations*, not only on the moon, but also on every celestial body in the solar system other than Earth and in the trajectories around and between them." (Italics added.)

The L-5 Society, a grass roots organization of space enthusiasts, goes much further. In the society's view, the treaty will prevent private enterprise—American or Western European—from venturing into space. Present plans and hopes for solar-power satellites, lunar mining, orbital factories, and space stations would all be wiped out by the stroke of a pen.

L-5 fears that the treaty will give the socialist nations an unbeatable advantage in space operations, establish a new "OPEC-like monopoly" that will control, regulate, and probably itself exploit our space resources, while erecting barriers to private American initiatives in space development.

PAINTING BY MARK RICKERSON

Proponents of the treaty say that this is an alarmist view, that the treaty will permit free enterprise in space (under international control) and that it is vitally necessary to establish a rule of law in space rather than first come, first-served competition. We have much more to gain from the treaty than we have to lose, they believe.

The treaty is a very broad and seemingly comprehensive document. It attempts to set up a body of law that will provide for exploration, research, and exploitation of natural resources in space. But because it is so broad the language is often vague and, in some places even contradictory.

The real battle, though, boils down to the interpretation of one key section of the Moon Treaty: Article XI, paragraph 7(d):

"An equitable sharing by all States Parties in the benefits derived from these resources, whereby the interests and needs of the developing countries as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon shall be given special consideration."

In other words, whatever profits are made on the moon or anywhere else in space must be shared in some manner with the Third World (noncommitted or developing) nations. The treaty further provides that an "International Regime" may be established by the United Nations to govern all activities in space, including the distribution of profits.

'Strangeholds on the moon," major American corporations cry.

In an advertisement in the February 14, 1980, *Washington Post*, United Technologies Corporations said flatly: "The draft agreement would have the effect of imposing an indefinite delay on commercial development of space at a time when the United States is a world leader in space technology."

Picture the problem from a corporate executive's point of view. He wants to move his company into space operations—manufacturing, mining, research, solar-power satellites, etc. This is an enormously expensive and risky undertaking, investing hundreds of millions of dollars in ideas and operations that have never been tried.

The only way to get a corporation to take such risks is to offer it some hope of making a profit. But how much profit can an executive expect when a bureaucracy from the United Nations not only will control what his company may or may not do in space but also will control the profits from all space operations and allot them in whatever manner it sees fit?

What does the corporate executive do? He waits. He does not recommend investing in space operations, at least not until he has a clearer picture of what the rules—and tax structure—are going to be.

Thus the Moon Treaty, if accepted by the United States, would lay the clammy hand of delay on any corporation's plans for developing commercial operations in space.

Such experts in space law as Edward R. French, an elected member of the International Astronautical Academy and an attorney who for many years chaired the Aerospace Law Committee of the American Bar Association, feel that the treaty can be amended to reflect U.S. interests. French was a special ambassador and twice a delegate to U.N. congresses.

He and many others believe that the treaty with certain reservations could protect American interests and extend the rule of law into space. He would attach "understandings" to the treaty such as:

> Article XI or any other article shall not limit the right of governmental or international agencies or private entities to explore and use the resources of the moon or other celestial bodies, including the right to exploit such resources for commercial or research purposes, pending an international regime if any.

The United States is already a signatory to the 1966 Outer Space Treaty, more formally titled the Treaty on Principles Governing the Activities of States in the Exploration and Uses of Outer Space, including the Moon and Other Celestial Bodies.

"The only way to get a corporation to risk the development of space is to offer profits. But how much profit can it expect when the U.N. controls profits and allots them as it sees fit?"

The Outer Space Treaty, which the United States ratified in 1967, basically provides that "weapons of mass destruction" will not be placed in space and that the moon will be a demilitarized area that no nation can claim sovereignty over much as Antarctica is treated by international law.

The Moon Treaty is considered by many to be an extension and elaboration of the basic principles of the Outer Space Treaty.

In 1970, while the Apollo program was at its height, Argentina submitted a draft treaty covering the moon and other celestial bodies to the legal subcommittee of the U.N. Committee on the Peaceful Uses of Outer Space. The draft was supported by Egypt, India, and the United States.

In 1971 the USSR responded by submitting its own draft of a treaty. Before the year was out, the U.N. General Assembly recommended that the committee consider the Soviet draft.

For more than seven years the diplomats wrangled over the draft agreement. During this time a group of Third World nations evolved the concept of "common heritage" regarding natural resources that are not within the territorial boundaries of any nation. The U.S. delegation placed a "common heritage" phrase in the first paragraph of Article X of the Moon Treaty.

The moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this agreement . . .

Why did our delegation insist on this wording? Partly for moralistic reasons, partly as rhetoric intended to curry favor with the Third World bloc in the United Nations. It was a case where the diplomats did not fully appreciate the political and commercial realities of developing natural resources in space.

The U.S. delegates and those who urge signing the treaty insist that "common heritage" does not mean "common property."

But the Third World does not see it this way at all. Ambassador M.C.W. Pinto, of Sri Lanka, as early as 1978 asserted, "The common heritage of mankind is the common property of mankind. The commonness of the common heritage is a commonness of ownership and benefit. The minerals are owned by your country and mine and by all the rest as well. . . . If you touch [them] in any way you touch my property. If you take them away, you take away my property."

In several of the five official languages of the United Nations, in which the treaty was written, the word *heritage* means patrimony, inherited property.

The treaty never defines specifically what a "natural resource" is, but it calls for an "International Regime" that will regulate exploitation of these space resources. How this bureaucracy will be set up, what its powers will be, how it will operate are all undefined by the treaty.

Only one point is clear. The Third World nations demand that the International Regime will run on a one-country one-vote system. Sri Lanka will have an equal voice with the United States in such an organization. Swaziland and Malta could outvote the People's Republic of China.

Some feel that the treaty's vagueness is its saving grace. By signing the treaty the United States commits itself only to the *principle* of working with an "international Regime," only to the *principle* of discussing profit-sharing agreements with Third World representatives.

But the treaty's opponents worry that even an agreement on vague principles will bring commercial development of space to a halt. Moreover, if we commit ourselves to discuss the principles of international control, it might be extremely difficult for the United States unilaterally to back out of the treaty once those principles harden into laws that we do not want to be bound by.

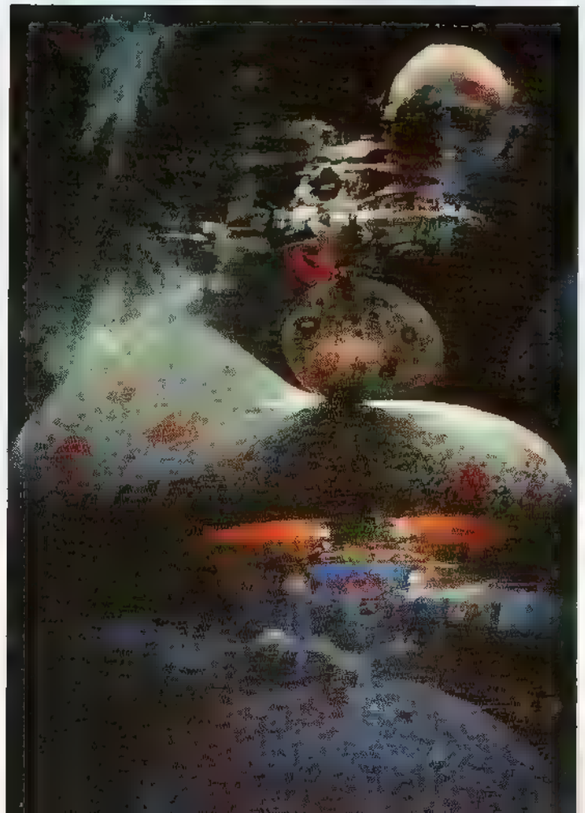
The purveyors of anti-American propaganda around the world would have a field day if the United States first signed the treaty and then later abrogated it.

CONTINUED ON PAGE 112

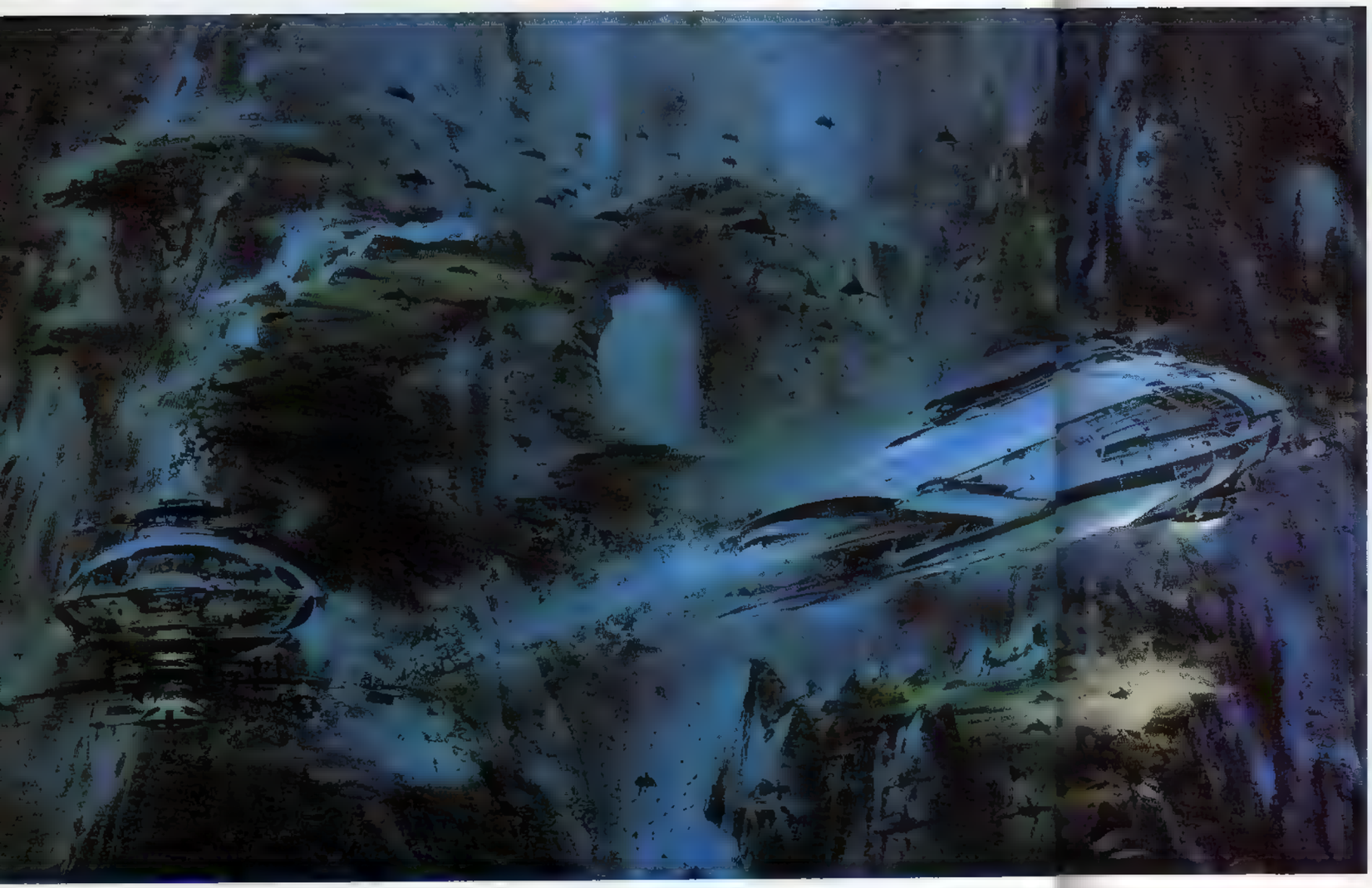
LIGHT VOYAGER

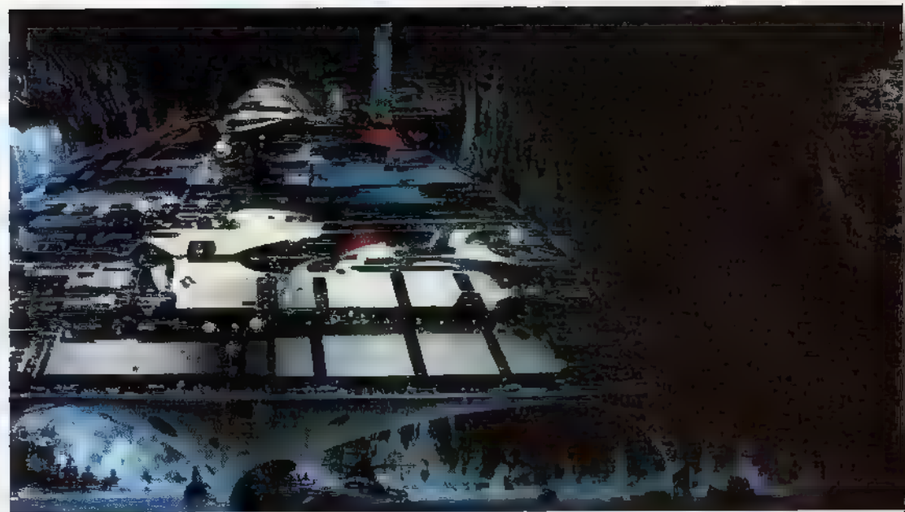
PAINTINGS BY JOHN BERKEY

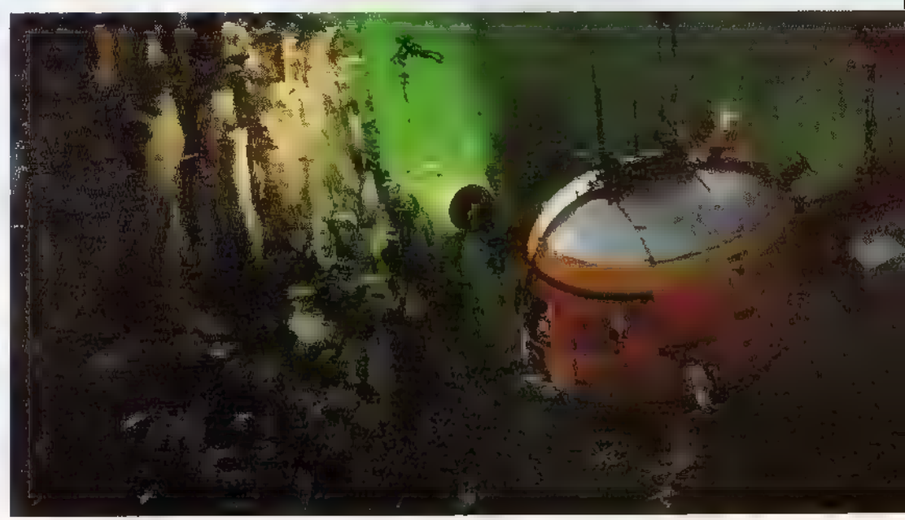
Starships emerge from the sullen monotony of space. Color-flecked contours vanish and reappear, depicting titanic dimensions. These radiant fortresses, both lyrical and defiant, herald an imagination sparked by the future of spaceflight.



"Berkey's behemoth space yachts rely on their own strength of composition and style rather than on technical accuracy."

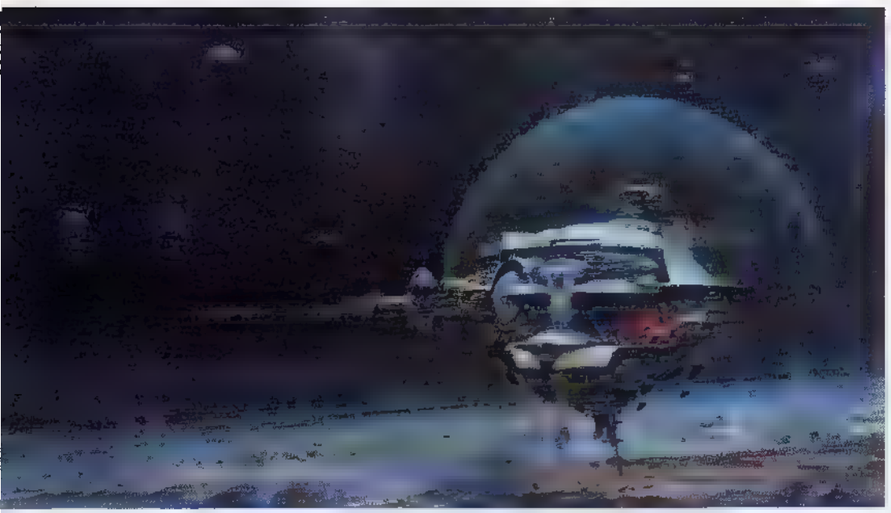


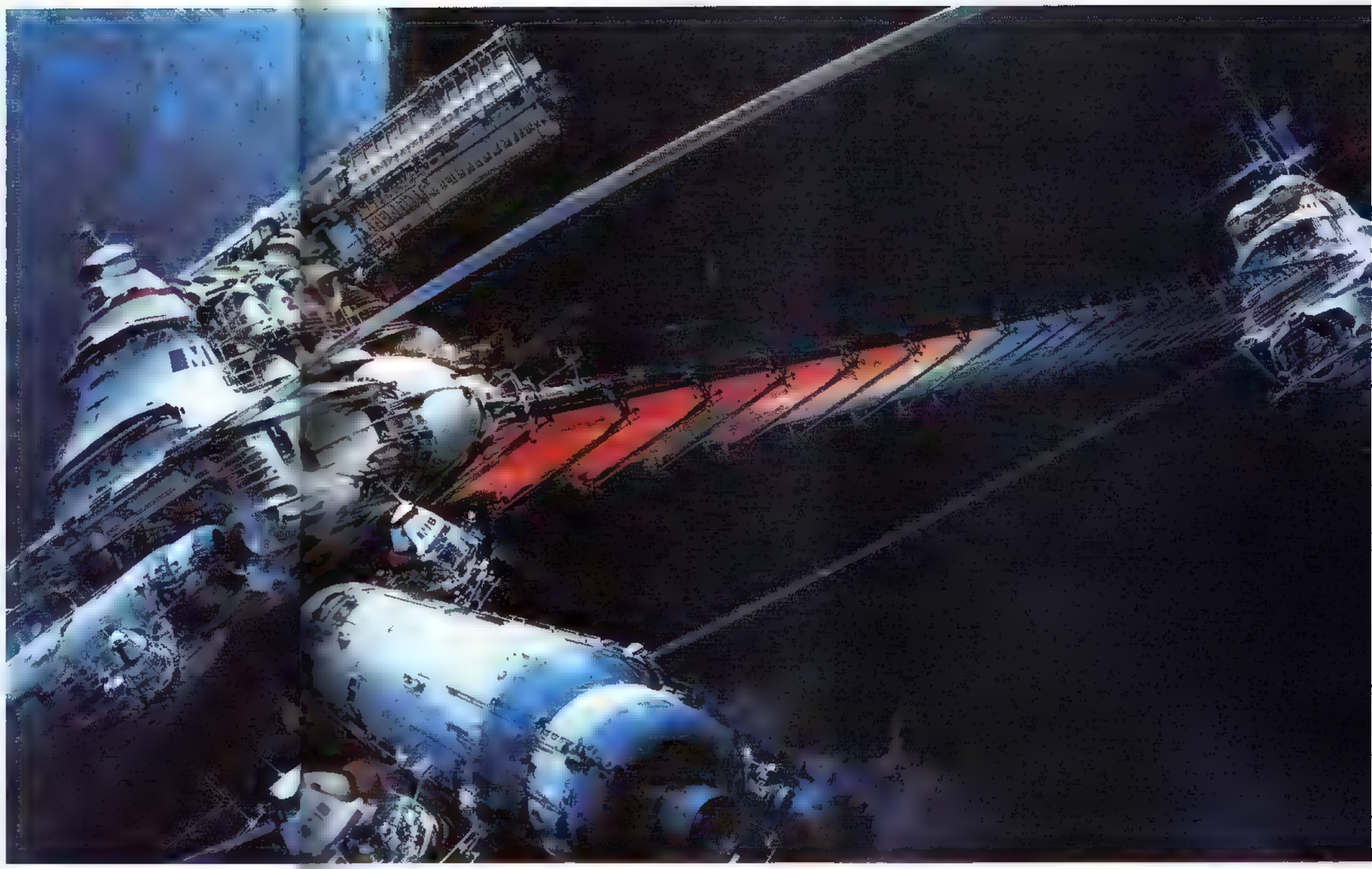




"I am uncomfortable with the business of being a science fiction artist," John Berkey says quietly. "I think of myself as an artist who paints science fiction pictures." Berkey's renderings of the future are not founded on technical descriptions of tomorrow's technology. Every painting begins with careful contemplation of where to place the light source. Spaceships are influenced as much by the artist's fascination with the human form as they are by the latest trends in aerodynamics. "Too many people are stuck on the idea that machines must have hard edges and

sharp corners. I don't know why a spaceship couldn't be vapor," says Berkey. "I prefer rounded forms as opposed to triangular shapes that zoom through the air. Perhaps it is because he is not constricted by scientific or literary convention that Berkey's far-future imaginings are so convincing. Fittingly, these futurescapes are created in a placid, earthbound setting. Berkey's at-home studio on a wooded expanse of lakeside land in Excelsior, Minnesota. "Beyond a certain point," the artist reflects, "the future provides total freedom to invent." ∞





"For an artist, there are hazards in knowing too much about engineering or technology. They can limit the imagination."

HEWLISH

CONTINUED FROM PAGE 66

I don't understand why men endow you with riches.

"Neither do. But I did hope you'd endow me with pancakes. You said you design the robots."

"Yes, which is why I can't see how you acquired a taste for an unprogrammed combination."

"Oh, but Roxanne and I had parents. Parents make all the difference. The four of us could program for six dishes and divide and share and combine as we wished, and not a morsel was wasted."

"Was your mother as giddy as you?"

"Oh yes. Papa said that coming home was like stepping onto a carousel. He never understood why Roxanne and left home to seek adventure, but Mama wished us good hunting."

"Will you ever say something amusing to me, Sibyl?"

"Not while I'm hungry."

"I veto the pancakes. Choose a viable category."

"You choose first."

Hewlish programmed firmly. "Dinner. Meat—steak. Vegetable—potato crisps. Vegetable—mixed salad. Beverage—coffee. Now serve."

He looked inquiringly at Sibyl. She said, "The steaks are always small. You didn't program a dessert. You really could eat a dessert, don't you think?"

"Like waffles and syrup?"

She smiled a slow, dazzling smile. "It would make me so happy."

He programmed the pancakes and waffles.

He scarcely tasted his dinner, so bewitched was he by her childish glee over the pancakes and jam. Before he realized how hungry he had been, the steak was gulped down, and the waffles followed just as quickly.

"I'm glad you suggested the pavilion," he said. "I feel much better."

Sibyl smiled to herself. "What else shall I suggest?"

"We could dance more than one dance at tonight's ball, though I would have to leave early. Tomorrow—" He stopped as if an electric shock had gone through him. "I forgot. The race, the defeat, everything. I forgot!"

"It's well forgotten. The defeat was my sister's doing."

Captain Mack would rather have her handling the job."

"I daresay he would. And she'd put him on the rocks fast enough. How could you let such mischief destroy your self confidence? Forget today."

"I can never forget it."

"But, dear Hewlish, you just forgot it completely."

"That was only because you were here—because you—" He paused. "Do you always keep the carousel turning?"

"It's fun, isn't it? Why stop it? When shall we meet at the ball tonight?"

"Just to dance?"

"What else does one do at a ball?"

"One pairs off if you're a huntress, you must pair."

"But I'm not hunting. Shall we meet at the same refreshment table about nine o'clock?"

"Eight o'clock."

"Very well. Now you may see me to my helix."

Meanwhile Roxanne had been at the Sail Club with Captain Mack, scanning racks of cassettes.

"The whole sail theory, if you're interested," he said gruffly.

"I am. Such a vast array makes me feel very ignorant. I was impertinent to poor Hewlish today."

"Yes. Upset him considerably. Hope he settles down tomorrow."

"Oh, he'll regain his confidence by then." Roxanne looked at the racks. "Sailing is a weighty matter."

"Do you read?"

"Yes. I was lucky in my schooling. My parents believed reading was a good mental discipline."

"In that case I can lend you a book that will be much less burden than cassettes on the same matter. But I'm keeping you late. Will you dine with me?"

"Yes, thank you. But only a brief meal. I'm eager to begin reading."

"Excuse me. You'll take good care of the book, won't you? Books are expensive and hard to replace. From observing you on my last space cruise, I did not suppose you even knew the alphabet."

Roxanne laughed. "Did you observe us? Sibyl and I were quite awed by your authority. It's nice to find you human."

"If I may say so, Roxanne, you're far more likable when you're not hunting.

"I enjoy being myself. How and when did it happen that literacy became the opposite of pleasure?"

"The perfection of voice programming and cassettes, I suppose, made literacy unnecessary to the lazy mind—and most human beings are lazy. Fortunately. If sailing were easy, the sport would be cluttered by robot minders and button pushers, as it was in the Early Atomic Age when modern civilization began."

"But you'll find the history of the Sail Reform Movement in the book," he went on. "A fair breeze and human brain and muscle—there's the real sport."

"It's all very exciting," Roxanne agreed.

When Sibyl returned from the ball at midnight, Roxanne was reading Captain Mack's book.

"You're taking great pains for my sake," said Sibyl.

"Captain Mack is no fool. By tomorrow my homework must be thoroughly done."

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"You underestimate my own powers with Hewlish."

"Never. You danced closely. I assume. He was dazzled by your touch, your perfume, your inconsequential, hypnotic chatter. Did you pair?"

"I think Hewlish is worth more than pairing. It would be fun to direct an inventive mind."

"Why, Sibyl. Would you mate with him?"

"I don't know. It would be so permanent. He's so serious. He'd never leave me while the offspring were young."

An advantage, surely? Nursery robots are tiresome. Remember ours? Papa and Mama were very useful."

Sibyl sighed. "But I do love luxury. How much would you let me take, Roxanne? Your jewels are grander than mine."

"Now here's a sisterly act. You leave me hunting alone and empty my jewel cases as well."

"Yes. And when you mate with a rich oligarch I shall expect magnificent presents. Our parents endowed us unequally with brains, and it's only fair that your abundance should make up for my lack."

Roxanne laughed and returned to reading the book.

The third and final race was the closest of all. The other boats, with few chances of winning the regatta, determined to spoil the day for the *Terran Hope*. Soon the protest flag was straining from her mast top as four after four blocked her progress.

Sibyl and Roxanne were watching the race on the viewscreen.

"How unfair!" said Sibyl. "A protest does no good from a tenth place."

"But the fouls only increase the crew's angry efforts."

"How do you know?"

"I know."

Never before had the *Terran Hope* been so tightly hauled. Never had she sailed so close to the wind. Her opponents fell off to leeward, and she outsailed them easily, racing between the orange finish buoys with a clear victory.

"They've won! Come, Sibyl," Roxanne said, standing up. "Now we can claim our prey."

Our? Sibyl wondered.

This time the *Terran Hope* was not so easily approached. The pier was crowded with well-wishers, regatta committeemen, and Trivector officials who had come to offer the formal challenge.

Sibyl and Roxanne waited until the ceremonies were completed and the crowd was thinning. Hewlish saw them and went up to them. They congratulated him, and Roxanne strolled toward the boat.

Hewlish said to Sibyl, "Roxanne must feel foolish, doubting my abilities."

"We both are pleased you won. But the victory has agitated you. I doubt that uncertainty, decisions, and fatigue are as pleasant as you boasted."

"They're pleasant to experience and overcome. The reliving of them is unpleasant. The thought of how near we came to failure. That's why I'm glad to see you, Sibyl. With you, I can remember the victory and forget the anxiety."

"Victory soon erases anxiety. Will you dance with me at tonight's ball?"

"Will you pair afterward?"

"Hewlish, I like you too much. I don't want to pair with you as I'd pair with prey. You're too fine and honest. I wish the holiday could go on forever."

"It can—as long as your nonsensical carouse keeps turning. Will you mate with me? I have little wealth, but you'd share it equally, such as it is."

"Oh, I accept you, dear Hewlish! I'm sorry you're not yet rich, but I'll never find a mate more clever or sensible."

Hewlish put his arms around her, pulled off her sunhood, kissed her smooth lips, and laid his cheek against her glossy hair.

She gently freed herself. "We must dine and dress for the victory ball."

"A victory within and beyond a victory!"

"How could I hunt? When I sail, my face will be sun reddened and ugly, my hands will bruise, my arm muscles will enlarge into unsightly lumps. I am a ruined huntress, I fear."

Hewlish exulted.

Roxanne had been talking to Captain Mack. They saw Hewlish embrace Sibyl, and the skipper scowled. "She caught him. I knew it. Poor fool!"

"I fear it's Sibyl who's caught," said Roxanne. "She spoke of wanting to mate with him. Not a brilliant match, but she was bored and restless. What was I to do?"

"Is Hewlish your doing?"

"I chose him, yes. Sibyl never has had my zest for the chase. Her nature is softer, more attuned to mating. I'll miss her dreadfully, of course."

"You made a good team, that's for sure. The old one-two," Captain Mack said with gusto. "A man never knew whether he was coming or going. You need a change of pace, Roxanne."

"Later. When I start hunting again. Now I'm fascinated by sailing."

"Don't hand me that sludge, girl. I'm not Hewlish."

"Exactly. Hewlish crewed for the *Terran Hope*. You own her. I'm studying your book. I hope you'll find a crew place for me if I follow you to Trivector."

"Hmm. You're not strong enough for jibman.

"Sailing skill is needed more in the light, shifting breezes than in the steady winds. I could be jibman when it pleased you, and rail crew at other times."

"I demand concentration in the regattas. You'd have to give up hunting."

"How could I hunt? When I sail, my face will be sun reddened and ugly, my hands will bruise, my arm muscles will enlarge into unsightly lumps. A ruined huntress. I fear. But the Trivector race—oh, I would give up much—everything—to win aboard the *Terran Hope*."

"And then?"

"I don't know. Why do you ask?"

"Because I'm a lonely man. I never mated when I was in the starship service, because I would seldom have seen my mate or offspring. I didn't mate when I retired, because I met no woman who shared my pass on for the sea." He paused. "Can a huntress understand that a man might have a passion for anything except—passion?"

"A huntress, of all people, knows that a man's passion is but an inner room of his heart. It must be approached by the right avenue, and there are as many avenues as there are men. Which is the fun of the hunt."

"I'll grant you all that, Roxanne, but we are still talking about two different things. Your hunt ends in a mutual pass on for each other. My yearnings have been toward a mutual passion for the sea."

"And for each other," Roxanne insisted gently.

"Yes, yes, of course," the captain agreed, "but my nature is such that I cannot separate the two."

"I think the sea is such a mistress," said Roxanne, "that she floods a man's heart and must be included."

"I perceive clearly that she has flooded *your* heart, Roxanne. I'm fairly well off," he went on, "I won't pair with you, wily Roxanne, because you'd rob me and walk away. But mating is a legal and permanent commitment. You couldn't rob me without robbing yourself."

"I've never robbed anyone, Captain Mack."

"As if bewitchment wasn't robbery of a man's senses and, afterward, of everything else he possessed."

"Now here's an odd proposal," Roxanne retorted. "The man distrusts me and yet would mate with me."

"I don't distrust your sailing. That's genuine enough to make young Hewlish green with envy. Nor do I distrust your ability to keep a mate amused if you kept your part of the bargain."

"I've never broken faith, either."

"Perhaps you think I'm too old for mating, but I'm capable of it, never doubt it!"

"Never for a second would I doubt," said Roxanne, laying her hand on the captain's sleeve. "I'm happy and honored to accept your offer. You'll be a handsome mate and a wonderful sire for our offspring."

"Lucky little bastards," said Captain Mack, grinning. ∞

THE TEN BEST GAMES OF THE YEAR

BY SCOT MORRIS

Space invaders are coming, and we don't mean Donner and Blitzen.

PHOTOGRAPH BY MICHAEL SOMOROFF

It was just two years ago that *Simon*, the musical follow-me game beeped its way into, and out of, every toy store in the country. By December it was sold out almost everywhere, and Milton Bradley had a gold mine that became the biggest selling game of both 1978 and 1979. Everyone wanted in on the act, and soon there were other electronic games that looked like *Simon* and played like *Simon*, with brand names as ironic as *Copy Cat* and *Monkey See, Monkey Do*. But new sophistication has inspired originality.

Electronic games have mushroomed. Now there are, by one estimate, nearly 400 from which to choose.

The problem with most of these games is staying interested in them. All too often the latest miracle of technology is an obsession for a week, or less, then sits on the shelf, its AA batteries slowly corroding into acidic mush.

So the companies bring out new games with new features to keep you interested: flashing lights, beeps and fanfares that can't be turned off, voice synthesizers that talk to you, and equipment that one company executive called the F.Y. Factor: those buzzers and Bronx cheers that razz you when you lose and taunt you to play again.

H. Allen Smith once observed that "man differs from other animals in his disposition for lists of Ten Best." To help readers through the crowded, expensive toy stores this year, we decided to follow Smith's rule.

The problem was reducing the field to just ten. First to be eliminated was *Rubik's Cube*, which would surely have made the list if we hadn't "done it to death" in the September and October Games columns.

We started by soliciting nominations from game buffs and friends. We considered only the newest games and the ones we judged would have the widest appeal to most *Omni* readers. We tried to choose games that were not like anything else on the market nor anything like one another. To remind ourselves that good games don't always require batteries, we looked at a selection of nonelectronic games and two of them made the final list. After trying every new game we could get our hands on, we got some ideas about where the game market is heading and what the hand-held games of the future will look like. Our humble speculations follow a discussion of the Top Ten Games of 1980.

All ten of these games are favorites. They are not listed in order of preference but by price, starting with the most expensive. Since "list prices" are often nonexistent in the

Above, counterclockwise, from top: Can't Stop, LCD Miracle Baseball, Block Buster, Fireman, Fireman Tennis, Bank Shot, Basketball, Ace of Aces, Space Invaders, Chess Challenger.

toy industry, our quoted prices are approximate and generally on the high side. Discounts are widely available.

1 ATARI SPACE INVADERS ($200 - $29.95)

Space Invaders is the most popular game ever to hit the arcades. Almost two years after its introduction it remains in first place, people still stand in line to play it. In Japan, where the game's owners at Taito, Inc. look on with glee, the game has become a national addiction. The Japanese government had to mint more 100-yen coins because so many of them were out of circulation in *Space Invaders* machines that a severe shortage was threatened.

The object of the game is to save the earth by shooting weird-looking aliens out of the sky before they land or hit you three times with their bombs. (Has anyone ever wondered what a real extraterrestrial would think of us if he got hold of one of these games?) If you want to experience the game at its best, play it in an arcade. But if you want to play *Space Invaders* on your TV set, get the Atari. The game itself is $29.95; the Atari Video Computer System necessary to play it can cost up to $200 but is widely discounted.

Incidentally, if you want a hand-held version of *Space Invaders*, the two best are by Bandai (*Super Galaxy Invaders*) and Entex (*Space Invader*). Entex is using the name and the game without paying a cent to Taito, by the way, on the grounds that a hand-held model is a new game. Needless to say, there's disagreement on this matter.

Atari now has 40 game cassettes available, most of which can be played alone or with partners, and with multiple permutations of oddball variables (*Space Invaders* boasts "112 Games," but most you'll never play). The best cassettes are *Breakout, Combat, Basketball, Night Driver, Golf, Circus, Adventure*, and *Superman*. Atari's address is 1265 Borregas Avenue, Sunnyvale, CA 94086.

2 SENSORY CHESS CHALLENGER (Fidelity $150)

Computer chess machines are now so sophisticated they offer a serious challenge to all but top-rated players. Competition between companies is fierce and programs are being improved every few months, so comparisons between brands are at best tentative. In September at the First World Microcomputer Chess Championships in London, *Chess Challenger* beat all comers, including new machines made in England, Switzerland, and the Netherlands, as well as the highly rated U.S. brands *Boris* and *Sargon 2.5*. For the moment, then, *Challenger* is king.

The *Challenger* now offers more than just a good game of chess. It is remarkably easy to play. No more do you have to figure out the rank and file of the piece you want to move and of the square you want to move it to. *Sensory Chess Challenger* has lights and sensors on each square. Press down on the piece you want to move, press it down again on the square you want to move it to, and it's done. The machine indicates its move by flashing one light on the square with the desired piece, another on the empty square the piece is moving to. This system feels more like playing chess and greatly reduces the chance of making errors - especially the kind you don't know you've made until several moves later when you are devastated by some move like "empty square takes your queen."

There is also a *Sensory Voice Chess Challenger* at more than twice the price ($360). The machine speaks its moves in an eerie, synthesized voice. The voice is a gimmick that wears thin after a while, but this game is worth mentioning for a second feature we like a lot. 64 of the greatest chess games of all time programmed into its memory. Game #2, for example, is Fischer vs. Spassky. You want to be Fischer? Fine. If you make the same move he did, the machine awards you a point, if

> *"At times our office looked like a Toys 'R' Us warehouse. The future will bring player's eye view displays, 3-D games, simulations of wind and water, and eventually a Robot Olympics."*

you get it on the second try, a half-point. You have the option of overriding the programmed game at any time, substituting your own move and seeing where it leads. This is a fascinating feature and an excellent teaching aid, but we hate to have to pay extra for the voice gimmick just to get it. We hope Fidelity Electronics will soon incorporate this 64 Great Games feature in its regular model. We'd also like to see electronic versions of go, shogi, and reversi (*Othello*), but we may have to wait. Reports are that several companies are trying to create a go-playing chip, but that the ancient Chinese game is so complex that nothing worth putting on the market has yet been created.

*Chess Challenger*s are from Fidelity Electronics, 8800 N.W. Thirty-sixth Street, Miami, FL 33178.

3 BANK SHOT (Parker Brothers $50)

Here's one of the cleverest ideas for an electronic game that we've seen. If you are put off by the tension of games in which you must race against a clock, another player or a computer-controlled opponent, try *Bank Shot* and take your time.

Bank Shot is a simulation of pool. You get a rack of six red balls and one bright red cue ball that can be aimed in eight directions, each of which can be straight, angled left, or angled right, for a total of 24 directions. That's nowhere near the flexibility of real pool, but it's not bad for the first game of its kind. Line up the cue ball for the break, aim, shoot, and watch the six balls bounce off one another and the cushions - and perhaps into a hole. Sink three racks of balls in the fewest number of shots to win. *Bank Shot* also allows you to place balls anywhere on the table so you can set up some outrageous trick shots. The game allows you to plan shots beforehand, mapping them out on a grid diagram, so you can begin using higher levels of strategy.

Queries should go to Parker Brothers Consumer Response Division, 50 Dunham Road, Beverly, MA 01915.

4 LCD MIRACLE BASEBALL (Bandai $50)

Of the hand-held baseball games (and there are plenty), we judged this one the best, not only for innovative design, a complex program, and, at large, handsome display, but for a booklet of well-written instructions that explain some of the computer-opponent's operating strategies and probabilities.

The playing field is a large silver LCD (liquid crystal display) screen. You can play against the machine (you bat for both the Home and the Visitor teams) or with a partner changing sides after each half-inning. As the ball-blip crosses the plate, the offensive player can press a button to swing (the direction of a hit ball depends on when the button is pressed, an early swing hits to left field, a late swing to right), another to bunt, or another if he already has a man on base to attempt a steal.

The defensive player has pitching controls that detach from the unit on a short wire so that he can hide the controls from the batter. He has several pitches available: straight, curve left, and curve right, each of which can be accelerated by pressing CHANGE UP. If the steal is on, he can try to cut it off, with degrees of success varying according to which base is being stolen and how quickly he reacts. If a pitch is hit, he can shift his outfielders into position to catch the ball. In all, an excellent simulation of the all-American game from Bandai, Japan's largest toy company whose American headquarters is at Bandai America, Inc., 6 Pearl Court, Allendale, NJ 07401.

5 MICROVISION BLOCK BUSTER (Milton Bradley $45)

Microvision is a hand-held game console. You buy the basic unit, then snap in individual game cartridges, purchased separately (about $15 each). It uses the energy-efficient LCD screen and so you can play it for a long time between battery changes.

There are now eight additional games available for *Microvision*, the newest being

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UNGREENING

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700 million people live in the dry lands.

Desert making and unmaking can be climatological. Twenty thousand years ago, long before the pleasant, semiarid era of the sub-Sahara's pastoralists, Saharan sands were 400 kilometers south of their present limits. Man was not an influence then, unless some great biodegradable civilization existed that we've never heard about. Experts still debate the matter, but the consensus is that the principal agent of our present desertification is man. In his overcultivation, overgrazing, burning, and wood collecting in the dry lands, *Homo sapiens* has become a geophysical force. Desertification is as old as civilization. It is mankind's first great crime against the planet we inhabit.

The world got a vivid reminder of that crime in the Sahelian drought of 1968 to 1973, when a quarter of a million people died. It was a costly demonstration, but this great drought in the Sahel introduced the word *desertification* to our language.

The Sahel is the region just south of the Sahara. Its boundaries are defined in various ways, most commonly by annual rainfall: a paltry 100 to 600 millimeters. The region includes parts of Senegal, Mauritania, Mali, Upper Volta, Niger, and Chad. Many of West Africa's great empires began here, centered on the Niger and Senegal rivers. Throughout history the Sahel has been a mixing ground. Nomadic peoples, the Moors and Tuaregs, dwell restlessly here, having migrated from the north, bringing Islam to the sub-Sahara (and with Islam the legend of the Mahdi, whom the Guild ships of Frank Herbert are supposed to bring in a few millennia to the outer reaches of the galaxy). Semi-nomadic people, such as the Fulani, a Hamitic tribe with origins in the east, live here, too, as do many sedentary farmers, members of various black tribes.

Drought is not a novel phenomenon in the Sahel. The survival strategies of desert pastoralists, time-tested, follow ancient patterns. In the Sahara the herdsmen disperse in all directions, breaking up into small groups and seeking surviving pockets of pasture. In the Sahel the herdsmen move south. The Peuls, a cattle-herding Sahelian people without a sense of roots, leave first. Camel and sheep herders leave later, for their animals fare better on parched grasses. The Tuaregs, hating to leave their traditional pastures, leave last.

The most recent drought, the one that coined *desertification*, differed only in that the Sahel was more densely populated than ever before. When the rains failed, an ecosystem already taxed by human numbers, there were more people around to die. By 1973, the fifth year of drought, Lake Chad had shrunk to a third its normal size. The Senegal and the Niger had failed repeatedly to flood, depriving the region's best farmland of necessary water and nutrients. Hundreds of thousands of nomads who had managed to cheat starvation were gathered into welfare camps.

Those Sahelian refugee camps where robed Tuaregs and Fulani herdswomen, nomads, try to retain their pride may seem far away, but the circumstances of their inescapable burden are close by. The red-brown Oklahoma fingers busy with sticks and little rocks are black in the Sahel and beringed, but they are the same fingers.

It is true that thousands of windbreaks were planted in the Great Plains during and after the desertification of the 1930s, and that the Dust Bowl gave way to fertile fields again. Oklahoma is proof of the resilience of dry-land ecosystems and of the efficacy of sound conservation practices. But we are backsliding now into our old bad habits. Conservation is no longer common on American farms. Our bad memories are at fault, or else our greed is. One indictment of U.S. agribusiness is that its drive for profit often ignores sound conservation practices. According to a report issued by the Government Accounting Office, our present erosion-control programs are failing. Soil losses are greater today than in 1935, when the Soil Conservation Service was established. Of our rangelands, 20 million hectares are in "poor" or "bad" condition because of overgrazing.

> *"In his overgrazing, overcultivation, wood collecting, and burning, it's clear that the principal agent of our desertification is man. . . . It may be mankind's first great crime against his own planet."*

The extreme example of how human numbers advance desertification, not surprisingly, is India. The Rajasthan Desert has been settled for centuries, but within the past 70 years its population has tripled. One region, the Luni Basin, has an average human density of 48 per square kilometer. For India this is sparse, but for *desert* it is jam-packed, the average density for other desert areas of the world is 3. In Rajasthan 48 humans are foraging each dry square kilometer for firewood, searching it for scanty pasture, cultivating its dunes. The vegetation deteriorates, and the wells are dug deeper.

The harshness of the Rajasthan Desert once gave it India's highest mortality rate. Thanks to modern medicine that rate has declined—a very small kindness, if a kindness at all, for Indians continue to be enormously successful at breeding themselves, and the die-off, when the big drought hits Rajasthan, will be horrendous.

To build the planet Dune, Herbert simply expanded the North African desert to cover an entire globe. A process very much like that is under way in the real world. We might say that nature is imitating Herbert's art, except that the process is not natural and the trouble began millennia before 1965 and the publication of *Dune*.

Man makes his deserts four ways.

First he expands rain-fed agriculture into areas where rainfall is erratic. Rain-fed agriculture is a venerable form. In the dry lands it was and is nomadic. A farmer sows his seeds in a wadi after rain, then returns later in the season to harvest. The method works best when human numbers are small. Human numbers are no longer small. Under pressure of population growth, agriculturalists have been tempted, against their better judgment, to gamble. When a succession of good rain years puts a hopeful blush on things, the farmer pushes into land that he knows is marginal. He plows the land, breaking the soil and clearing it of indigenous plants and grasses—the vegetation best adapted to that land, best suited to retaining its scant moisture and to holding its poor soils in place, the vegetation best prepared for drought. The rains fail, the crops wither, the soil blows away, the farmer departs.

Our second contribution to desertification is made by ill-planned irrigation of dry lands. Irrigation in dry country can produce spectacular results, especially at first, because solar radiation there is so high. The drawback is that high solar radiation has another effect besides stimulating chlorophyll; it accelerates evaporation. In hot country rapid evaporation leaves a residue of salts and other ions on the soil. Half of all irrigated soils in the dry lands suffer from salinization. Some 1,250 square kilometers of irrigated land is degraded throughout the world annually, the same rate at which new land is brought under cultivation. The irrigated field, then, is a kind of mirage: a half truth.

Overgrazing is the third way whereby man despoils the land. When nomadic pastoralists are restricted in their movements, when dry land farmers impinge on their pastures, when the herdsmen themselves grow too numerous, then their herds make deserts. When commercial ranchers grow greedy or unwise, running too many animals inside their fences, then they, too, become desert makers.

And the fourth way that man speeds the coming of deserts is by collecting wood. The tree is the best antidesert invention yet. Its canopy shades the ground beneath; its roots grasp the soil in place; its falling leaves make humus, and its presence breaks the wind. In gathering their firewood, poor men and women are creating deserts throughout the Third World.

"We must do a thing on Arrakis never before attempted for an entire planet," his

father said. "We must use man as a constructive ecological force. Inserting adapted terraform life, a plant here, an animal there, a man in that place... to transform the water cycle, to build a new kind of landscape."

Egypt's Aswan Dam was an attempt to make the desert bloom. It succeeded in increasing food production, but with disastrous side effects: salinization, siltation, waterlogging of desert soils, epidemic increases of such waterborne diseases as schistosomiasis, destruction of the eastern Mediterranean's sardine fishery, drowning of antiquities.

Another forthcoming project is the Jonglei Canal, to be constructed in Sudan. The canal would divert Nile water around the Sudd, the world's largest swamp, in order that 80 000 hectares of swampland might be drained and properly irrigated. If completed, the project may alter rainfall patterns, expand desertification in countries neighboring Sudan, increase evaporation at Aswan Dam, and put up a barrier to the migrations of the Nuer, Dinka, and Shilluk cattle herders of southern Sudan. It will upset the ecology of a great swamp.

More promising are modest technologies that don't try so hard to push the earth around. Remote sensing by satellite is beginning to prove its worth as a monitor of desertification.

In drier regions the infrared sensor of an Earth Resources Technology Satellite has provided a kind of establishing shot, a reminder of the larger forces at play. Satellites above the Sahara and the Sahel record how the dunes align themselves with prevailing air circulation, reworked each year by the Harmattan, a powerful wind. But more valuable will be imagery in finer detail. Focusing on the sand seas, the serif dunes, the overlapping transverse and herringbone dunes, and the upsilodal dunes of a region like the Sahel, which boasts all those kinds, the satellite may soon be capable of detecting incipient dune migration. Thermal infrared imagery can detect moisture. Satellites can see the warning signs of desertification in vegetated land, a change in soil color to lighter shades as the finer, darker organic surface materials are winnowed out. Orbiting above, the satellite can watch the earth bleach itself as desertification advances.

In poor nations, like those of the Sahel, an advantage of remote sensing is that it is cheap, relative to the amount of information provided. If this comes to pass in the Sahel—if Space Age satellites do someday monitor the Stone Age movements of Tuaregs in the desert—then that meeting of ages will have been prefigured in *Dune*, where the weather satellites of the Spacing Guild watch the green of Fremen experiments in desert reclamation.

The fictional "soft" reclamation technology of *Dune*—dew reapers, dew precipitators, moisture traps—has a real-life analogue in the practices of the Israelis, who are the best desert farmers in the world today. Israel, employing plastic mulches, greenhouses, and trickle irrigation and practicing controlled grazing, has greened vast areas of the Negev Desert. Plastic mulches and greenhouses slow evaporation. Trickle irrigation conserves water, providing roots with just the amount they need. There are problems, unfortunately, in advancing Israel as a model. Desert reclamation as practiced in Israel is capital-intensive, requiring financial assistance from Jews around the world. Most of the world's deserts have no such constituency. There is no well-to-do merchant or professional class of Tuaregs or Fulani or Berbers or Navajos in New York, London, or Amsterdam. Many desert lands are Islamic and following Israel would be a bitter pill—as many Arab nations' delegates demonstrated at the UN Conference on Desertification in 1977, when they walked out rather than listen to the Israeli presentation. Israel's technology is not unflawed either; the Israelis are experiencing serious problems with nitrate pollution and with increasing salinity in the country's coastal aquifer.

While Israel's desert retardant mulch is plastic, Iran's is bituminous. Iran does battle with advancing dunes in its fleets of sand crawlers—tractors pulling tar-black tank cars. At least they once did. But before they did battle with advancing Iraqis, gunners at nozzles atop tank trailers sprayed broadsides of petroleum residue at the dunes. The spray dries to a gray mulch, crusts the dunes over, stabilizes them, and provides a rudimentary moisture-gathering soil. Tamarisks and other fast-growing dry-land trees are planted in the mulch, and soon petroforests grow where sand once blew.

Success in Iran, as in the Negev, is simply a return to the ingenuity of ancient times. Two thousand years ago a system of canals in the Negev hills caught runoff in the rainy season. Irrigated low farmland that received only eight to ten centimeters of natural precipitation a year, and fed millions of people. Three thousand years ago in Iran, water from the highlands was piped through subterranean aqueducts down to lowland fields. The aqueducts, called *qanawaat*, are still watering Iranian fields. (Frank Herbert liked the idea of the *qanat* for dry regions so well that both the technology and the name *qanat* went unchanged into the Imperium, where the Fremen used them to fill their secret reservoirs.)

In desert reclamation, simpler is usually better. One workable technique, or non-technique, has been simply to fence a section of desert field and off from man and his animals, then trust to the ingenuity of plants to reclaim it. Experiments in Iran's Dasht e Kavir have shown nearly complete recovery of ground cover and biomass after 12 years of total protection. Similar results have been obtained in the sandy soils of Mauritania and southern Tunisia.

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For much of this planet's dry lands, grazing by domestic animals is now, and probably will always be, the most efficient way for humans to use the land. There is nothing inherently wrong with dry-land grazing. When the herdsman is free to move to where the grass grows, when his herds are of sensible size, when dry land farmers have not encroached on his customary pastures, then grazing is a sustainable use of resources. The salvation of much of our arid and semiarid land is to ensure that grazing does not turn into overgrazing.

This will not simply be a question of education. Desert herdsmen know all about desert ecology already. Its truths are ingrained in them; their nomadic way of life is a response to desert realities. But they also need to fill their own bellies in this lifetime. One private study explains it. "Recognizing that land left ungrazed for a time will regenerate, they nevertheless graze hard, because land left for tomorrow will benefit another." A report of the U.N. Conference on Desertification says "The main difficulties in making the pastoralists themselves responsible for the protection of land resources. This will require the development of new formulas for the land-owning system and for social organization, both preferably based on existing social structures."

U.N. scientists are calling for a remaking of desert society. The scientists are predominantly Caucasians. They may seem high handed — when was the last time the United Nations called for a remaking of *European* society? — but then Europe is not disappearing under dunes. The remaking of an ancient way of life will, of course, be far easier said than done.

Desertification presents a dilemma to those of us who love the desert. Man-made deserts ultimately come to resemble the real thing. The wind patterns the dunes with ripples; sidewinders carve their tracks on the leeward slopes; dune-shaped clouds sail skies of turquoise hue. Dune seas are the purest of landscapes, even more often than the scrubby steppes and nomadic encampments that preceded them.

Then too, most desertification does not culminate in the purity of dunes. It ends in steppes, remarkable only in being poorer and scrubbier than they were before being broken by the hooves of man's animals and the iron of his plowshares.

If there is an inaccuracy in *Dune*, it is in Herbert's suggestion that Arrakis is infamous as a hellhole everywhere in the Imperium. In fact, from the evidence of our own solar system, desert landscapes are the most common in creation. Compared to Mars, the planet for which we once had such great hope, Arrakis is lush. Compared to Mercury, Arrakis is drowning.

For desert lovers there are already plenty of xeric worlds around. Earth is the one planet known to have produced a single lichen, much less a tree. We should work at keeping it that way. We should leave desert making to the Desert Maker, Who has had so much more practice. ∞

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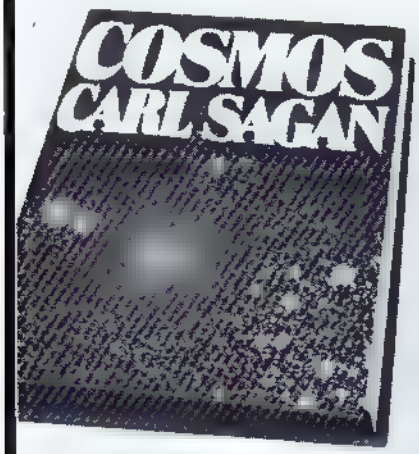

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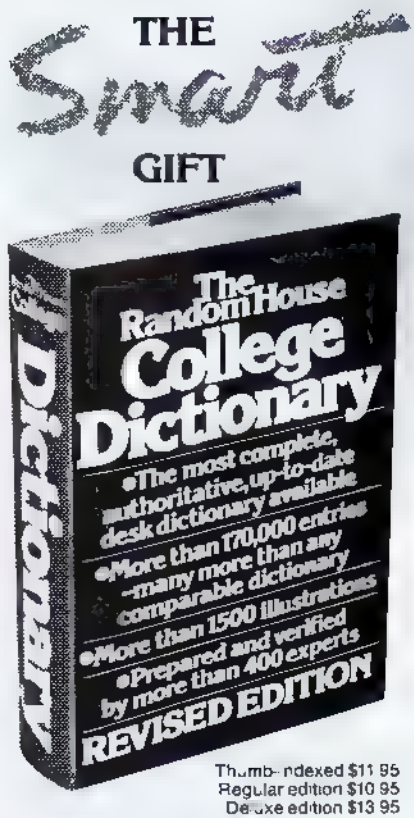

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MOONSTRUCK!

CONTINUED FROM PAGE 94

The debate over the treaty has already engendered bitter strains and tensions within such normally placid organizations as the American Bar Association and the American Institute of Aeronautics and Astronautics.

The International Law Section of the ABA, for example, recommended that the association support the treaty. However, at the ABA's annual meeting last August in Honolulu, both the Natural Resources Section and the Science and Technology Section opposed such a recommendation so strongly that the whole topic was removed from the meeting's agenda.

The ABA took no action on the treaty but has rescheduled the topic for its semi-annual meeting in Houston next month (January 1980). The Young Lawyers Section is also getting into the picture and is undecided as to its position.

The strains within the AIAA were revealed last July when Dr. Louis Friedman and Dr. Jerry Grey (a frequent contributor to *Omni*) testified on AIAA's behalf before Senator Adlai Stevenson's Subcommittee on Science, Technology and Space.

Drs. Friedman and Grey testified that AIAA cannot "recommend unequivocal support either for or against a U.S. signature and ratification of the treaty. There are those among our members who urge that it be signed and ratified, but only subject to certain understandings and interpretations required to deal with portions of the treaty that give rise to specific concerns. There are also AIAA members who urge that the United States not sign the treaty at all, or that we sign it only if these concerns are dealt with by rewording the treaty itself."

Among the first voices raised against the Moon Treaty was that of J. Anderson Dorman, the managing editor of this magazine. In a First Word in the November 1979 *Omni*, Dorman pointed out, "The ... treaty has been carefully designed by Communist and Third World parties to discourage private industry's role in developing the resources of outer space ..."

The Third World view of the Moon Treaty is obviously different. Dr. Rashmi Mayur, director of the Urban Development Institute of Bombay and a member of the Futurology Commission of the Government of India, told *Omni*,

"The Moon Treaty is an important instrument in bringing a new order in the exploration and development of the almost-unlimited resources of the moon and other celestial bodies. ... If planetary politics are extended to space, whoever commands space will control the earth.

"Considering the widening gap between the rich and the poor nations," Dr. Mayur continued, "as well as the technological disadvantages the latter suffer, [the treaty] emphasizes that the benefits of developments on the moon and in space should reach those who are most deprived and thus eliminate the shame of poverty that has beleaguered the majority of humanity for centuries."

The Moon Treaty is not the first attempt by the United Nations to establish a rule of international law beyond the territorial jurisdictions of individual nations.

Like outer space, the seabeds of Earth's oceans are rich in natural resources. But the development of these resources was halted before it ever began because the nations of the world could not agree on who owned what.

For more than ten years the United Nations attempted to produce a definitive Law of the Sea agreement, but the very same "common heritage" expression prevented an agreement from being reached. The industrialized nations do not want their seabed mining operations controlled by the Third World; the poor nations demand that the riches of the sea must be shared by all.

Leigh S. Ratiner, a Washington, D.C., attorney who represents the L-5 Society as a lobbyist, was one of the principal American negotiators on the Law of the Sea Conference from 1969 to 1977. In his testimony on September 6, 1979, before the House Subcommittee on Space Science and Applications, Ratiner traced the "common heritage" concept back to the mid-1970s, when the idea was adopted by a political caucus of Third World nations called the Group of 77.

The Group of 77 published a declaration calling for a "New International Economic Order," based on the rationale that "fundamental justice requires that those who receive the raw materials and natural resources that fuel and feed industrialized economies must be required to pay a significant share of their economic wealth in exchange for access to those resources."

In other words, a consortium of Third World nations seeing the success of OPEC in escalating petroleum prices decided to try the same tactics on resources *that they neither owned nor had any chance of controlling*.

Until warning voices such as *Omni*'s and Ratiner's were raised, it appeared likely that President Carter would sign the Moon Treaty—which, after all, had been negotiated by his U.N. delegation—and that the Senate would routinely ratify it. No one in Washington seemed to understand or care about the long-term significance of the treaty.

But the L-5 Society and other space enthusiasts clamored for a careful review of the treaty's provisions before any signing or ratification. The national media finally awoke to the situation, and articles about the treaty began to appear in major newspapers and weekly newsmagazines, and even in scientific and technical journals.

Often the news media's treatment of the story was condescending. WOULD-BE SPACE COLONISTS FIGHT AGAINST MOON TREATY, the *Washington Post* headlined on the day of Ratiner's testimony before the House

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The November 1979 issue of *Science* reviewed the situation under the heading EARTHLINGS AT ODDS OVER MOON TREATY. The January 7, 1980, Baltimore *Sun* headed a story, MOON WARS: UN PACT OPPOSED AS PRO-SOCIALIST. Ten days later the *Catholic News*, of New York, asked AN OPEC IN SPACE?

On March 9, 1980, the *New York Times* stirred itself to ask, TREATY ON THE MOON IS IT TOO SOON?

Other forces were at work. Late in October 1979 Senators Frank Church (Democrat of Idaho) and Jacob Javits (Republican of New York), the chairman and the ranking minority member, respectively, of the Senate Foreign Relations Committee, sent a firm letter to Cyrus Vance, then secretary of State. Their letter made it clear that if the President signed the Moon Treaty the Foreign Relations Committee would recommend against Senate ratification.

"The provisions of the so-called Moon Treaty borrow heavily from the Third U.N. Law of the Sea Conference," the Church-Javits letter states. It goes on to note that the U.N. interpretation of the common-heritage concept "... does not conform to the national interests of the United States or of other countries with free enterprise/free market economies."

That is where the matter stood until November 4, 1979, when Iranian terrorists seized the American embassy in Tehran. That's where the matter still stands since Congress has devoted its attention to the Iranian crisis, the Soviet invasion of Afghanistan, the Fiscal Year 1981 budget and the 1980 election campaign. Vance resigned as secretary of State and was replaced by former Maine Senator Edmund Muskie.

The Carter Administration soon cooled off on signing the treaty, so the new Congress, which will convene in January, will take up the question afresh—and with no great sense of haste or urgency.

Meanwhile the treaty was passed unanimously by the U.N. General Assembly, the U.S. delegation voting "aye" along with everyone else: Canada, Chile, France, the Philippines, and Romania have signed the treaty. Since the treaty provides that the agreement goes into effect upon the signature of five nations, the treaty is now international law—for the nations that have signed. If the United States eventually signs and ratifies the treaty, it will become binding upon every American citizen, having the full force of federal law.

The USSR has not signed the treaty, perhaps because compliance would oblige the Soviet Union to be much more open about its plans and activities in space, notifying the U.N. bureaucracy about future space operations, and opening up Soviet space facilities to international inspection.

"Thank God for the G-5 Society," said one Russian administrator, *sotto voce*.

Apparently the Soviet Union is willing to sign the treaty if the United States does. The inference is that the Russians will give up some measure of secrecy in order to forestall the expansion of U.S. industrial enterprise into space.

Even the most adamant opponents of the treaty agree that the resources of space must be shared in some manner with poor nations. But they insist that the treaty, as it now stands, would prevent free enterprise from moving into space, and this would greatly diminish the benefits that could be returned to Earth.

"Laws must follow human experience," says attorney Dula, who believes that any attempt to codify space laws before human beings undertake long-term operations in space is putting the cart before the horse. "There's no basis for judgment."

But claims are already being staked in space. In 1976 the nations of Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda and Zaire signed the Declaration of Bogotá, in which these equatorial nations laid claim to the geostationary orbit—the 24 hour orbit that lies 35,900 kilometers above the equator.

Both the United States and the Soviet Union have denounced the declaration and have stated clearly that the geostationary orbit is in free space, under the terms of the 1966 Outer Space Treaty.

In September 1980 the United Nations finally passed its Law of the Sea Treaty, with its 'common heritage' wording concerning seabed resources. If the United States signs and ratifies that treaty, all American commercial operations involving ocean resources will have to be preapproved by a U.N. organization called the Enterprise, and all profits from such operations will be shared through the Enterprise with Third World nations.

Will the United States sign either treaty? There is apparently no great enthusiasm in Washington to do so. While international legal experts like Finch recommend ratification with 'understandings' attached, other lawyers point out that such 'understandings' have no effect in international law, according to the Vienna Convention on International Treaties.

In other words, no matter what understandings we attach to such treaties, only the treaty itself becomes binding international law. Insisting on no treaty at all would be unacceptable to the State Department.

The betting in Washington is that the United States will eventually sign an amended Moon Treaty and will try to work within an international legal framework to allow private American and European corporations to move into space.

Former Apollo astronaut William Anders was quite precise about it: "The earth is really not the center of the universe. When you look at it from the moon and it looks the size of your fist at the end of your arm, you don't see any international boundaries. If we on this grain of sand can't cooperate in space as mankind ... and utilize this new medium for the benefit of all of us, then we likely won't get together on anything and we'll bring about our own extinction." ∞

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ST. AMY'S TALE

CONTINUED FROM PAGE 90

heart of hearts and recombining it in new ways. Hearts were broken too often where he worked, and one of the little animals escaped and killed people until they lay in great heaps like fish in the ship's hold.

But this was not the destruction of the world.

Oh, they were giants in those days, and they forgot the Lord, but when their people lay in piles of moldering flesh and brittling bone, they remembered they were weak.

Mother Elouise said, "Charlie came weeping." This is how Father Charlie became an angel. He saw what the giants had done by thinking they were greater than God. At first he sinned in his grief. Once he cut his own throat. They put Mother Elouise's blood in him to save his life. This is how they met. In the forest where he had gone to die privately, Father Charlie woke up from a sleep he thought would be forever to see a woman lying next to him in the tent and a doctor bending over them both. When he saw that this woman gave her blood to him whole and unstintingly, he forgot his wish to die. He loved her forever. Mother Elouise said he loved her right up to the day she killed him.

When they were finished, they had a sort of ceremony, a sort of party. "A benediction," said Bill, solemnly sipping at the gin. "Amen and amen."

"My shift," Charlie said, stepping into the cockpit. Then he noticed that everyone was there and that they were drinking the last of the gin, the bottle that had been saved for the end. "Well, happy us," Charlie said, smiling.

Bill got up from the controls of the 787. "Any preferences on where we set down?" he asked. Charlie took his place.

The others looked at one another. Ugly-Bugly shrugged. "God, who ever thought about it?"

"Come on, we're all futurists," Heather said. "You must know where you want to live."

"Two thousand years from now," Ugly-Bugly said, "I want to live in the world the way it'll be two thousand years from now."

"Ugly Bugly opts for resurrection," Bill said. "I, however, long for the bosom of Abraham."

"Virginia," said Elouise. They turned to face her. Heather laughed.

"Resurrection," Bill intoned, "the bosom of Abraham and Virginia. You have no poetry, Elouise."

"I've written down the coordinates of the place where we are supposed to land," Elouise said. She handed them to Charlie. He did not avoid her gaze. She watched him read the paper. He showed no sign of recognition. For a moment she hoped that it had all been a mistake, but no. She would not let herself be misled by her desires.

"Why Virginia?" Heather asked.

Charlie looked up. "It's central."

"It's east coast," Heather said.

"It's central in the high survival area. There isn't much of a living to be had in the western mountains or on the plains. It's not so far south as to be in hunter-gatherer country and not so far north as to be unsurvivable for a high proportion of the people. Barring a hard winter."

"All very good reasons," Elouise said. "Fly us there, Charlie."

Did his hands tremble as he touched the controls? Elouise watched very carefully, but he did not tremble. Indeed, he was the only one who did not. Ugly-Bugly suddenly began to cry, tears coming from her good eye and streaming down her good cheek. *Thank God she doesn't cry out of the other side.* Elouise thought; then she was angry at herself, for she had thought Ugly-Bugly's deformed face didn't bother her anymore. Elouise was angry at herself, but it only made her cold inside, determined that there would be no failure. Her mission would be complete. No allowances made for personal cost.

Elouise suddenly started out of her contemplative mood to find that the two other women had left the cockpit—their sleep shift, though it was doubtful they would sleep. Charlie silently flew the plane, while Bill sat in the copilot's seat, pouring himself the last drop from the bottle. He was looking at Elouise.

"Cheers," Elouise said to him.

He smiled sadly back at her. "Amen," he said. Then he leaned back and sang softly:

Praise God, from whom all blessings flow
Praise him, ye creatures here below
Praise him, who slew the wicked host
Praise Father, Son, and Holy Ghost

Then he reached for Elouise's hand. She was surprised, but let him take it. He bent to her and kissed her palm tenderly. "For many have entertained angels unaware," he said to her.

A few moments later he was asleep. Charlie and Elouise sat in silence. The plane flew on south as darkness overtook them from the east. At first their silence was almost affectionate. But as Elouise sat and sat, saying nothing, she felt the silence grow cold and terrible, and for the first time she realized that when the airplane landed, Charlie would be her—Charlie, who had been half her life for these last few years, whom she had never lied to and who had never lied to her—would be her enemy.

I have watched the little children do a dance called Charlie El. They sing a little song to it, and if I remember the words, it goes like this:

I am made of bones and glass
Let me pass, let me pass
I am made of brick and steel
Take my heel, take my heel
I was killed just yesterday
Kneel and pray, kneel and pray
Dig a hole where I can sleep
Dig it deep, dig it deep

Will I go to heaven or hell?
Charlie El Charlie-El

th nk they are already nonsense words to the ch dren. But the poem first got passed word of mouth around Richmond when was itt e, and ving in Father M chae s house The ch ldren do not try to answer their song. They just s ng it and do a very clever little dance wh e they sing They always end the song with a the chi dren fa ng down on the ground augh ng That s the best way for the song to end

Charlie brought the a rp ane straight down nto a field, great hot winds pushing aga nst the ground as if to shove t back from the p ane The field caught fire, but when the p ane had settled upon ts three whee s, foam streaked out from the belly of the mach ne and overtook the f ames Elouise watched from the cockp t thinking *Wherever the foam has touched, nothing will grow for years.* t seemed symmetr ca to her Even in the ast moments of the ast mach ne it must poison the earth Elou se held Amy on her ap and thought of try ng to expla n t to the chi d. But Elouise knew Amy wou d not understand or remember

Last one dressed is a sissy wissy," sa d Ug y Bugly in her husky ancient sound ng voice. They had dressed and undressed n front of each other for years now, but today as the old plast c-po uted clothing came off and the homespun went on they felt and acted ke schoo kids on the r first day n coed gym Amy caught the spirit of t and kept yelling at the top of her lungs No one thought to quiet her There was no need This was a ce brat on

But Elou se, long accustomed to self exam nat on, forced herself to rea ize that there was a stra n to her frol cking She d d not be eve t not really. Today was not a happy day, and t was not just from know ng the confrontation that ay ahead There was something so fina about the death of the ast of the eng nes of mankind Sure y something could be but she forced the thought from her, forced the co dness in her to overtake that sentiment Surely she cou d not be seduced by the beauty of the a rp ane Surely she must remember that it was not the mach nes but what they inev tably did to mank nd that was ev l

They looked and fe t a little awkward almost s lly as they left the plane and stood around in the blackened field They had not yet lost their fee for sty sh clothing, and the homespun was so umpy and awkward and rough It didn t look right on any of them

Amy clung to her dol., awed by the strange scenery In her ife she had been out of the airp ane on y once and that was when she was an nfant She watched as the trees moved unpredictab y She winced at the wind in her eyes She touched her cheek where her ha r moved back and forth in the breeze and hunted through her vocabu ary for a word to name the strange nvis ble touch on her skin "Mommy," she said. Uh! Uh! Uh!

Elou se understood "Wind." she said The sounds were still too hard for Amy, and the ch ld d d not attempt to say the word *Wind*, thought E o se, and immed ate y thought of Charlie. Her best memory of Charlie was in the wind It was during his death-wish time, not long after his su cide He had insisted on c mbing a mounta n and she knew that he meant to fal So she had c mbed w th him, even though there was a storm coming up Charlie was angry all the way. She remembered a terr ble hour c ng ng to the face of a cliff, held on y by sma bits of metal forced nto cracks in the rock She had nsisted on rema ning tied to Charlie. "If one of us fell, it would only drag the other down, too," he kept saying "I know" she kept answering. And so Charlie had not fa en, and they made love for the first t me in a shallow cave with the wind how ng outside and occas onal sprays of rain coming in to dampen them. They re-fused to be dampened. Wind Damn

And Elouise felt herself go cold and un-emot onal, and they stood on the edge of the field in the shade of the f rst trees Elouise had eft the Rectifier near the plane set on 360 degrees In a few minutes the Rectifier would go off, and they had to watch, to witness the end of the r work

Suddenly Bill shouted aughed, held up his wrist "My watch!" he cried

Hurry," Charlie said. "There s time

Bi unbuckled his watch and ran toward

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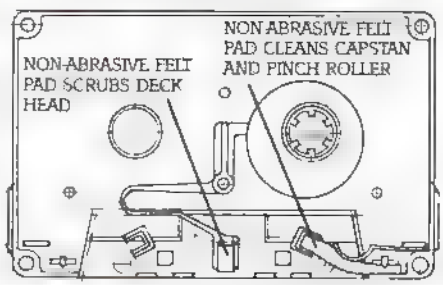

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the Rect fier He tossed the watch It landed within a few meters of the smal mach ne Then B ll returned to the group jogging and shaking his head "Jesus what a moron Three years wip ng out everyth ng east of the M ssiss pp and I almost save a digital chronograph "

"Dix e Instruments? Heather asked

'Yean "

'That s not h gh techno ogy, she said and they all augned Then they fell si ent and Elouise wondered whether they were all thinking the same thing that jokes about brand names would be dead w th n a gen eration, if they were not a ready dead They watched the Rect fier in silence, waiting for the timer to finish its de ay Suddenly there was a shin ng n the air a dazzling not-light that made them squ nt They had seen this many times before from the a r and from the ground, but this was the last t me and so they saw it as f it were the first

The airplane corroded as if a thousand years were passing in seconds But it wasn't true corros on. There was no rust— on y disso ution as molecules separated and seeped down into the oosened earth Glass became sand; plastic corrupted to o. the meta also drifted down into the ground and came to rest .n a vein at the bottom of the Rectifier field Whatever else the metal might look ke to a future geo.og st it would n't look like an artfact t wou d look like iron And w th so many simi ar pockets of iron and copper and alum num and t n spread ar over the once-c vi zed wor d, it was not l kely that they would suspect human interference Elouise was amused thinking of the treatises that wou d someday be written, about the two states of workable meta s the ore state and the pure-metal ve n She hoped it would retard their progress a tle

The airplane shivered into nothing, and the Rect fier also died n the field A few minutes after the Rectifier disappeared, the field a so faded

'Amen and amen," said Bill maudin aga n "A clean now.

E ouse on y smi ed She said nothing of the other Rect fier, which was n her knapsack Let the others th nk all the work was done

Amy poked her finger in Charie's eye Charlie swore and set her down Amy started to cry, and Char e knel by her and hugged her Amy's arms went t ghtly around h s neck. "Give Daddy a k ss," Elou se sa d

'Well time to go," Ugly-Bugly's voice rasped. "Why the he l did you p ck this particular spot?"

Elouise cocked her head 'Ask Charlie "

Char e f ushed Elouise watched him grimly "Elou se and I once came here, he sa d "Before Rectificat on began Nostalgia, you know He smi ed shyly and the others laughed Except Elou se She was help ng Amy to ur nate She felt the weight of the small Rect fier in her knapsack and d d not tel anyone the truth that she had never been n V rg nia before in her life

"Good a spot as any," Heather said Well, bye "

We bye. That was all, that was the end of it, and Heather walked away to the west, toward the Shenandoah Val ey

'See ya " Bill sa d—

"L ke hell." Ug y-Bug y added

Impulsive y Ug y-Bugly hugged Elouise and B ll cried, and then they took off north east toward the Potomac, where they wou d doubt essly find a community grow ing up along the clean and f sh fi ed river Just Charl e, Amy, and Elou se left n the empty, b ackened field where the a rp ane had died E ouise tried to feel some great pa n at the separat on from the others but she could not. They had been together every day for years now going from supply dump to supply dump wrecking cities and towns, destroying and us ng up the artificial world But had they been friends? If it had not been for their task they wou d never have been fr ends They were not the same kind of people

And then E ou se was ashamed of her fee ings Not her k nd of peop e? Because Heather ked what grass did to her and had never owned a car or had a driver's license n her l fe? Because Ug y-Bugly had a face hideously deformed by cancer surgery? Because B l always worked Jesus nto the conversation, even though half the t me he was an athe st? Because they just weren't n the same soc a circles? There were no social circles now Just people trying to surv ve in a bitter world they weren't bred for There were only two c asses now those who would make t and those who wou dn t

Which class am I? thought Elouise

'Where should we go?" Char e asked

Elouise picked Amy up and handed her to Charlie "Where's the capsu e, Charl e?"

Char e took Amy and said, 'Hey Amy, baby I bet we f nd some farming commu n ty between here and the Rappahannock."

'Doesn't matter if you tel me Char e The nstruments found it before we anded You did a damn good job on the computer program " She didn't have to say Not good enough

Charlie only sm led crookedly "Here I was hop ng you were forgetful " He reached out to touch her knapsack. She pulled abrupt y away He ost h s sm le 'Don t you know me?" he asked softly

He would never try to take the Rect fier from her by force But st ll. This was the last of the artifacts they were talking about. Was anyone rea y predictab e at such a time? E ou se was not sure She had thought she knew h m wel before yet the time capsu e ex sted to prove that her understanding of Char e was far from comp ete

"I know you Charlie," she sa d "but not as wel as thought. Does t matter? Don't try to stop me "

"I hope you're not too angry," he said E ou se couldn t th nk of anyth ng to say

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to that. *Anyone could be fooled by a traitor, but only I am fool enough to marry one.* She turned from him and walked into the forest. He took Amy and followed.

All the way through the underbrush Elouise kept expecting him to say something. A threat, for instance. You'll have to kill me to destroy that time capsule. Or a plea. You have to leave it, Elouise, please, please. Or reason, or argument, or anger, or something.

But instead it was just his silent footfalls behind her, just his occasional playtalk with Amy, just his singing as he put Amy to sleep on his shoulder.

The capsule had been hidden well. There was no surface sign that men had ever been here. Yet, from the Rectifier's emphatic response it was obvious that the time capsule was quite large. There must have been heavy, earth-moving equipment. Or was it all done by hand?

"When did you ever find the time?" Elouise asked when they reached the spot.

"Long lunch hours," he said.

She set down her knapsack and then stood there, looking at him.

Like a condemned man who insists on keeping his composure, Charlie smiled wryly and said, "Get on with it, please."

After Father Charlie died, Mother Elouise brought me here to Richmond. She didn't tell anyone that she was a Wrecker. The angel had already left her and she wanted to blend into the town, be an ordinary person in the world she and her fellow angels had created.

Yet she was incapable of blending in. Once the angel touches you, you cannot go back, even when the angel's work is done. She first attracted attention by talking against the stockade. There was once a stockade around the town of Richmond, when there were only a thousand people here. The reason was simple. People still weren't used to the hard way. Life was without the old machines. They had not yet learned to depend on the miracle of Christ. They still trusted in their hands, yet their hands could work no more magic. So there were tribes in the winter that didn't know how to find game, that had no reserves of grain, that had no shelter adequate to hold the heat of a fire.

"Bring them all in," said Mother Elouise. "There's room for all. There's food for all. Teach them how to build ships and make tools and sail and farm, and we'll all be richer for it."

But Father Michael and Uncle Avram knew more than Mother Elouise. Father Michael had been a Catholic priest before the destruction, and Uncle Avram had been a professor at a university. They had been nobody. But when the angels of destruction finished their work, the angels of life began to work in the hearts of men. Father Michael threw off his old allegiance to Rome and taught Christ simple, from his memory of the Holy Book. Uncle Avram plunged into his memory of ancient metallurgy and taught the people who gathered at Richmond how to make iron hard enough to use for tools. And weapons.

Father Michael forbade the making of guns and forbade that anyone teach children what guns were. But for hunting there had to be arrows, and what will kill a deer will also kill a man.

Many people agreed with Mother Elouise about the stockade. But then in the worst of winter a tribe came from the mountains and threw fire against the stockade and against the ships that kept trade alive along the whole coast. The archers of Richmond killed most of them, and people said to Mother Elouise, "Now you must agree we need the stockade."

Mother Elouise said, "Would they have come with fire if there had been no wall?"

How can anyone judge the greatest need? Just as the angel of death had come to plant the seeds of a better life, so that angel of life had to be hard and endure death so the many could live. Father Michael and Uncle Avram held to the laws of Christ simple, for did not the Holy Book say, "Love your enemies, and smite them only when they attack you; chase them not out into the forest, but let them live as long as they leave you alone"?

I remember that winter. I remember watching while they buried the dead tribesmen. Their bodies had stiffened quickly, but Mother Elouise brought me to see them and said, "This is death. Remember it. Remember it." What did Mother Elouise know? Death is our passage from flesh into the living wind, until Christ brings us forth into flesh again. Mother Elouise will find Father Charlie again, and every wound will be made whole.

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Elouise knelt by the Rectifier and carefully set it to go off in half an hour, destroying itself and the time capsule buried thirty meters under the ground. Charlie stood near her, watching his face nearly expressionless, only a faint smile broke his perfect repose. Amy was in his arms, laughing and trying to reach up to pinch his nose.

"This Rectifier responds only to me," Elouise said quietly. "Alive. If you try to move it, it will go off early and kill us all."

"I won't move it," Charlie said.

And Elouise was finished. She stood up and reached for Amy. Amy reached back, holding out her arms to her mother. "Mommy," she said.

Because I couldn't remember Father Charlie's face, Mother Elouise thought I had forgotten everything about him, but that is not true. I remember very clearly one picture of him, but he is not in the picture.

This is very hard for me to explain. I see a small clearing in the trees, with Mother Elouise standing in front of me. I see her at my eye level, which tells me that I am being held. I cannot see Father Charlie, but I know that he is holding me. I can feel his arms around me, but I cannot see his face.

This vision has come to me often. It is not like other dreams. It is very clear, and I am always very afraid, and I don't know why. They are talking, but I do not understand their words. Mother Elouise reaches for me, but Father Charlie will not let me go. I feel afraid that Father Charlie will not let me go with Mother Elouise. But why should I be afraid? I love Father Charlie, and I never want to leave him. Still I reach out, reach out, reach out, and still the arms hold me, and I cannot go.

Mother Elouise is crying. I see her face twisted in pain. I want to comfort her. "Mommy is hurt," I say again and again.

And then, suddenly, at the end of this vision I am in my mother's arms and we are running, running up a hill, into the trees. I am looking back over her shoulder. I see Father Charlie then. I see him, but I do not see him. I know exactly where he is, in my vision I could tell you his height. I could tell you where his left foot is and where his right foot is, but still I can't see him. He has no face, no color, he is just a man-shaped emptiness in the clearing, and then the trees are in the way and he is gone.

Elouise stopped only a little way into the woods. She turned around as if to go back to Charlie. But she would not go back. If she returned to him, it would be to disconnect the Rectifier. There would be no other reason to do it.

"Charlie, you son of a bitch!" she shouted.

There was no answer. She stood, waiting. Surely he would come to her. He would see that she would never go back, never turn off the machine. Once he realized it was inevitable, he would come running from the machine, into the forest, back to the clearing where the 787 had landed. Why would he want to give his life so meaninglessly? What was in the time capsule, after all? Just history—that's what he said, wasn't it? Just history, just films and metal plates engraved with words and microdots and other ways of preserving the story of mankind. "How can they learn from our mistakes, unless we tell them what they were?" Charlie had asked.

Sweet, simple, naive Charlie. It is one thing to preserve a hatred for the killing machines and the soul-destroying machines and the garbage making machines. It was another thing to leave behind detailed, accurate, unquestionable descriptions. History was not a way of preventing the repetition of mistakes. It was a way of guaranteeing them. Wasn't it?

She turned and walked on, not very quickly, out of the range of the Rectifier, carrying Amy and listening all the way for the sound of Charlie running after her.

What was Mother Elouise like? She was a woman of contradictions. Even with me she would work for hours teaching me to read, helping me make tablets out of river clay and write on them with a shaped stick. And then, when I had written the words she taught me, she would weep and say, "Lies, all lies." Sometimes she would break the tablets I had made. But whenever part of her words was broken, she would make me write it again.

She called the collection of words The Book of the Golden Age. I have named it The Book of the Lies of the Angel Elouise, for it is important for us to know that the greatest truths we have seem like lies to those who have been touched by the angel.

She told many stories to me, and often I asked her why they must be written down. "For Father Charlie," she would always say.

"Is he coming back then?" I would ask.

But she shook her head, and finally one time she said, "It is not for Father Charlie to read. It is because Father Charlie wanted it written."

"Then why didn't he write it himself?" I asked.

And Mother Elouise grew very cold with me, and all she would say was, "Father Charlie bought these stories. He paid more for them than I am willing to pay to have them left unwritten." I wondered then whether Father Charlie was rich, but other things she said told me that he wasn't. So I do not understand, except that Mother Elouise did not want to tell the stories, and Father Charlie, though he was not there, constrained her to tell them.

There are many of Mother Elouise's lies that I love, but I will say now which of them she said were most important.

1. In the Golden Age for ten times a thousand years men lived in peace and love and joy, and no one did evil one to another. They shared all things in common, and no man was hungry while another was

No, I don't enjoy the evergreen's rustic beauty or the fresh pine smell in my home. I just enjoy murdering inferior life forms with an ax."

full and no man had a home while another stood in the rain, and no wife wept for her husband killed before his time.

2. The great serpent seems to come with great power. He has many names. Satan, Hitler, Lucifer, Nimrod, Napoleon. He seems to be beautiful, and he promises power to his friends and death to his enemies. He says he will right all wrongs. But really he is weak, until people believe in him and give him the power of their bodies. If you refuse to believe in the serpent, if no one serves him, he will go away.

3. There are many cycles of the world. In every cycle the great serpent has arisen, and the world has been destroyed to make way for the return of the Golden Age. Christ comes again in every cycle also. One day, when He comes, men will be even in Christ and doubt the great serpent, and that time the Golden Age will never end, and God will dwell among men forever. And all the angels will say, "Come not to heaven but to Earth, for Earth is heaven now."

These are the most important lies of Mother Elouise. Believe them all, and remember them, for they are true.

All the way to the airplane clearing Elouise deliberately broke branches and let them dangle so that Charlie would have no trouble finding a straight path out of the range of the Rectifier even if he left his flight to the last second. She was sure Charlie would follow her. Charlie would bend to her as he had always been: resilient and accommodating. He loved Elouise, and Amy he loved even more. What was in the metal under his feet that would weigh in the balance against his love for them?

So Elouise broke the last branch and stepped into the clearing and then sat down and let Amy play in the unburnt grass at the edge while she waited. *It is Charlie who will bend,* she said to herself, *for I will never bend on this. Later I will make it up to him, but he must know that on this I will never bend.*

The cold place in her grew larger and colder until she burned inside, waiting for the sound of feet crashing through the underbrush. The damnable birds kept singing so that she could not hear the footsteps.

Mother Elouise never hit me, or anyone else, so far as I knew. She fought only with her words and silent acts, though she could have killed easily with her hands. I saw her physical power only once. We were in the forest to gather firewood. We stumbled upon a wild hog. Apparently it felt cornered, though we were weaponless; perhaps it was just mean. I have not studied the ways of wild hogs. It charged not Mother Elouise, but me. I was five at the time, and terrified. I ran to Mother Elouise, tried to cling to her, but she threw me out of the way and went into a crouch. I was screaming. She paid no attention to me. The hog continued rushing, but seeing I was down and Mother Elouise was erect, it changed its path. When it came near, she leaped to the side. It was not nimble enough to turn to face her. As it lumbered past, Mother Elouise kicked it just behind the head. The kick broke the hog's neck so violently that its head dropped and the hog rolled over and over and, when it was through rolling, it was already dead.

Mother Elouise did not have to die.

She died in the winter when I was seven. I should tell you how life was then, in Richmond. We were only two thousand souls by then, not the large city of ten thousand we are now. We had only six finished ships trading the coast, and they had not yet gone so far north as Manhattan, though we had run one voyage all the way to Savannah in the south. Richmond already ruled and protected from the Potomac to Dismal Swamp. But it was a very hard winter, and the town's leaders insisted on hoarding all the stored grain and fruits and vegetables and meat for our protected towns, and let the distant tribes trade or travel where they would, they would get no food from Richmond.

"Father Michael forbade the making of guns and forbade that anyone teach children what guns were. But for hunting there had to be arrows, and what kills a deer will also kill a man."

It was then that my mother, who claimed she did not believe in God, and Uncle Avram, who was a Jew, and Father Michael, who was a priest, all argued the same side of the question: it's better to feed them than to kill them, they all said. But when the tribes from west of the mountains and north of the Potomac came into Richmond and spread pleading for help, the leaders of Richmond turned them away and closed the gates of the towns. An army marched then to put the fear of God, as they said, into the hearts of the tribesmen. They did not know which side God was on.

Father Michael argued and Uncle Avram stormed and fumed, but Mother Elouise silently went to the gate at moonrise one night and alone overpowered the guards. Silently she gagged them and bound them and opened the gates to the hungry tribesmen. They came through weaponless, as she had insisted. They quietly went to the storehouses and carried off as much food as they could. They were found only as the last few fled. No one was killed.

But there was an uproar, a cry of treason, a trial and an execution. They decided on beheading because they thought it would be quick and merciful. They had never seen a beheading.

It was Jack Woods who used the ax. He practiced all afternoon with pumpkins. Pumpkins have no bones.

In the evening they all gathered to watch, some because they hated Mother Elouise, some because they loved her, and the rest because they could not stay away. I went also, and Father Michael held my head and would not let me see. But I heard.

Father Michael prayed for Mother Elouise. Mother Elouise damned his and everyone else's soul to hell. She said, "If you kill me for bringing life, you will only bring death on your own heads."

"That's true," said the men around her. "We will all die. But you will die first."

Then, "I'm the luckier," said Mother Elouise. It was the last of her lies, for she was telling the truth, and yet she did not believe it herself, for I heard her weep. With her last breaths she wept and cried out, "Charlie! Charlie!" There are those who claim she saw a vision of Charlie waiting for her on the right hand of God, but I doubt it. She would have said so. I think she only wished to see him. Or wished for his forgiveness. It doesn't matter. The angels had long since left her, and she was alone.

Jack swung the ax and it fell, more with a smack than a thud. He had missed her neck and struck deep in her back and shoulder. She screamed. He struck again, and this time silenced her. But he did not break through her spine until the third blow. Then he turned away, spattered with blood, and vomited and wept and pleaded with Father Michael to forgive him.

Amy stood a few meters away from Elouise, who sat on the grass of the clearing, looking toward a broken branch on the nearest tree. Amy called, "Mommy! Mommy!" Then she bounced up and down, bending and unbending her knees. "Da! Da!" she cried. "La la la la la." She was dancing and wanted her mother to dance and sing too. But Elouise only looked toward the tree, waiting for Charlie to appear. *Any minute,* she thought. *He will be angry. He will be ashamed,* she thought. *But he will be alive.*

In the distance, however, the air all at once was shining. Elouise could see it clearly because they were not far from the edge of the Rectifier field. It shimmered in the trees, where it caused no harm to plants. Any vertebrates within the field, any animals that lived by electricity passing along nerves, were instantly dead, their brains stilled. Birds dropped from tree limbs. Only insects droned on.

The Rectifier field lasted only minutes.

Amy watched the shining art. It was as if the empty sky itself were dancing with her. She was transfixed. She would soon forget the airplane, and already her father's face was disappearing from her memories. But she would remember the shining. She

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would see it forever in her dreams: a vast thickening of the air, dancing and vibrating up and down, up and down. In her dreams it would always be the same: a terrible shining light that would grow and grow and grow and press against her in her bed. And always with it would come the sound of a voice she loved, saying, "Jesus, Jesus, Jesus." This dream would come so clearly when she was twelve that she would tell it to her adopted father, the priest named Michael. He told her that it was the voice of an angel speaking the name of the source of all light. "You must not fear the light," he said. "You must embrace it." It satisfied her.

But at the moment she first heard the voice, in fact and not in dream, she had no trouble recognizing it. It was the voice of her mother, Elouise, saying, "Jesus." It was full of grief that only a child could fail to understand. Amy did not understand. She only tried to repeat the word: "Deeah-zah."

"God," said Elouise, rocking back and forth, her face turned up toward a heaven she was sure was unoccupied.

"Dog," Amy repeated. "Dog dog doggie." In vain she looked around for the four-footed beast.

"Charlie!" Elouise screamed as the Rectifier field faded.

Daddy," Amy cried, and because of her mother's tears she also wept. Elouise took her daughter in her arms and held her rocking back and forth. Elouise discovered that there were some things that could not be frozen in her. Some things that must burn. Sunlight. And lightning. And everlasting, unextinguishable regret.

My mother, Mother Elouise, often told me about my father. She described Father Charlie in detail, so I would not forget. She refused to let me forget anything. "It's what Father Charlie died for," she told me, over and over. "He died so you would remember. You cannot forget."

So I still remember, even today, every word she told me about him. His hair was red, as mine was. His body was lean and hard. His smile was quick, like mine, and he had gentle hands. When his hair was long or sweaty it kinked tightly at his forehead, ears, and neck. His touch was so delicate he could cut in half an ant so tiny it could not be seen without a machine, so sensitive that he could fly—an art that Mother Elouise said was not a miracle since it could be done by many giants of the Golden Age and they took with them many others who could not fly alone. This was Charlie's gift, Mother Elouise said. She also told me that I loved him dearly.

But for all the words that she taught me, I still have no picture of my father in my mind. It is as if the words drove out the vision, as so often happens.

Yet I still hold that one memory of my father, so deeply hidden that I can neither lose it nor fully find it again. Sometimes I wake up weeping. Sometimes I wake up with my arms in the air curved just so, and remember that I was dreaming of embracing that large man who loved me. My arms remember how it feels to hold Father Charlie tight around the neck and cling to him as he carries his child. And when I cannot sleep, and the pillow seems to be always the wrong shape, it is because I am hunting for the shape of Father Charlie's shoulder, which my heart remembers, though my mind cannot.

God put angels into Mother Elouise and Father Charlie, and they destroyed the world, for the cup of God's indignation was full, and all the works of man were an abomination. All the works of men become dust, but out of dust God makes men, and out of men and women, angels. ∞

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SUPERGENE

CONTINUED FROM PAGE 82

We were holding everything else constant but varying this," he explained. "The longer-lived strains displayed better DNA repair than the short-lived strains. Since the mice were exactly alike genetically, except for the MHC region, the better DNA repair of the long-lived strains had to be due to more effective regulation of repair by the supergene region.

At about the same time Cutler's lab in Baltimore was zeroing in on biochemical processes that protect cells from internal damage. This past spring Cutler and his colleagues Julie Tolmasoff and Tetsuya Ono reported a startling relationship between amounts of a vital protective enzyme and life span in different mammalian species. They found a clear correlation between the concentrations of the crucial protective enzyme superoxide dismutase and the amount of energy the animal will use during its life span. (Total energy consumed is directly related to longevity.)

Superoxide dismutase (SOD) is found in all animals that use oxygen to obtain energy from food. When oxygen is used, small amounts of a reactive chemical, superoxide, are formed, and this substance wreaks havoc inside cells. The superoxide radicals are like hit and run drivers or insane gunmen shooting at crowds from the tops of towers. They go berserk and knock out vital working elements in the cell. Here's where SOD comes to the rescue, mopping up superoxide radicals before they can do irreparable harm. SOD, along with catalase (another protective enzyme), is the Batman and Robin of the intercellular world," said one biologist.

Cutler's lab measured the amounts of SOD in 12 primate species and discovered an excellent correlation between concentrations of the enzyme and metabolic longevity. "Longer-lived species have a higher degree of protection against the by-products of oxygen metabolism," Cutler concluded, increasing the effectiveness of SOD may indeed contribute to the longevity of species.

In January Cutler read an article in *Science* magazine that for him constituted a breakthrough. A group of biologists at the University of Szeged in Hungary, reported that they had traced SOD regulation to the MHC. They had used the same inbred mouse system that Walford had used. "That was the tip-off," Cutler said. "They found that levels of SOD in liver tissue are either raised or lowered by mutations in the MHC. This really turned me on, because it looked as if the MHC governed levels of superoxide dismutase, which in turn is involved in governing aging rates.

Then I looked at Walford's paper reporting that mutations in MHC changed DNA repair capacity. So my idea was that maybe the major histocompatibility complex might be the longevity-determining supergene controlling many different repair and protective processes.

Walford and Cutler's research had uncovered some really important clues in the case of the missing regulatory gene — pointing straight to the MHC as the control center for many protective processes.

Higher levels of repair and protective processes might mean greater resistance to environmental hazards. It might be possible to increase people's natural resistance to toxic chemicals — perhaps to help them recover from accidental exposure. "By enhancing an individual's normal level of repair of genetic damage," Cutler says, "we might prevent their cancer twenty years later."

Cutler was not then and is not now suggesting that an enzyme cocktail would prolong life or allow one to live with complete impunity on top of Love Canal. But the fact that many of these processes may be congruent on the same MHC genetic locus suggested that they might all be controlled simultaneously. "It is easy to visualize," he said cautiously, "how enhancement could lead to a longer, more vigorous life."

All vertebrates possess an MHC-type gene cluster. Among the immune functions under its aegis are resistance to leukemia viruses and spontaneous tumors, resistance to various autoimmune diseases, the development of suppressor cells for immunoresponse to "self", and the age specific response to immune stimulatory agents.

Several years ago Walford tested his hypothesis that the MHC is a supergene controlling immune functions and that mutations around the MHC locus affect aging. He compared 14 strains of inbred mice against 3 standard strains as controls. The longest-lived strains exhibited the best MHC system response and the shortest-lived, the worst — evidence that the gene complex had an enormous effect on the immune system and on aging.

Also from Walford's busy laboratory came evidence that cyclic nucleotide levels undergo tremendous changes in aging normal human cells and in the cells of people suffering from diseases of accelerated aging such as Downs syndrome and lupus erythematosus. "Cyclic nucleotides are present in almost every cell," Walford remarked. "It is a ubiquitous system and they do lots of things. Their main role is to play second messenger. When certain hormones hook onto receptors in the cell wall, a cyclic nucleotide meets it and carries the hormone's message into the nucleus. There the hormone signals the gene that instructs the cell to manufacture a protein or do whatever it wants done.

If there is any imbalance in cyclic nucleotide levels, cellular messages get scrambled, wrong orders are made up, and in wrong size batches, and so on. Or no messages get there at all.

Walford and his colleague C. R. Tam found that in human lymphocyte cells the

eve s of two critica cyc c nucleot des cyc c adenosine monophosphate (cAMP) and cyclic guanosine monophosphate (cGMP)—are drast cal y altered with age These molecu es, especially cAMP, are known to have widespread control and affect a cell's differentiation as wel as ts metabolism and division

Researchers at Johns Hopk ns Un versity had reported that eve s of cAMP and cGMP were a so altered by mutat on of the MHC Now it seemed as if cyclic nuc eotides too were involved w th the supergene and hormone regu at on was drawn into the MHC's sphere of influence

Mak ng the connection, Cut er found a correlation of cyclic-nuc eot de evels with life spans in var ous pr mate spec es, as he had done with SOD and other protective enzymes Now that cyclic nuc eot des were mplicated in the supergene machinery, the stakes were even higher. The possibility ex sted that the MHC genes were nvolved n the highest evels of cellular, and ult mately whole organ regulat on.

f hormones are "thrown out of whack by mutat ons on the MHC one biolog st specu ated you m ght get an incapacitated ab ity to react to thyrox n, or you m ght br ng on hormone dysfunct on, which in turn br ngs on menopause and a whole host of d sagreeab e things

Everything s n an exqu site interre ated balance " says Wa ford, "and that's the problem D srupt it at any stage and you can cause ag ng

Why is this important today? Tremendous amounts of literature ex st reporting diseases that corre ate w th spec f c mutat ons in the MHC Yet th s amaz ng supergene can provide medical science with a "win dow on the molecu ar landscape" for every nd vidual The MHC codes certain proteins that form patterns un que in each per son Now, by means of a fasc nat ng proc ess ca ed HLA typ ng of these protein patterns we can ident fy specific HLA genotypes or genetic profiles. Cut er raises the poss b l ty that HLA typ ng may be used to reveal a person s levels of SOD, DNA repair, and so on "It wou d pred ct not on y h s susceptib l ty to certain diseases but also how the b ochemical bas s of th s susceptib l ty can be reduced

'People who had a peculiar pattern might be prone to d abetes cancer, or a who e mess of d seases One might be able to pred ct from HLA data f you cou d pred ct defic encies in a twenty year-o d, through enzyme therapy you could help h m Instead of increas ng the overall l fe span of the popu at on we cou d square the curve a tt e bit g v ng us an ear y iden t f cat on of people who are aging at a faster rate Then you cou d fix them up

' t makes so much sense that the MHC [shou d be] involved in rates of aging, ' Cut er theor zes 'The immune system is a very basic life-maintenance process It doesn t help us run and it doesn't help us read All t does s protect the same role as SOD, DNA repair and the others '

As hypothes zed by Wa ford, the mmune system may be the first organ n the body to fall apart with ag ng It slow y ages, and ts ab l ty to do ts job is mpaired; it slow y turns aga nst tse f produc ng autoantibodies and many of the immune diseases. Longer life span, Wa ford suggests m ght resu t if the mmune system could be augmented to protect t from ag ng The real so ut on s to stabilize t rather than to fight aga nst the aftereffects

Can we a ter the MHC? If many of the genes are c ustered together, that gives you more opportunity to work on it n terms of genetic engineering, ' Cut er says, a though he and a number of other sc ent sts caution aga nst unqua if ed optim sm

' th nk t's a prob em the recombinant DNA peop e should look into, ' Wa ford proposes

Most genetic sts think we ve got a long way to go before we can direct y nterfere n the human genome. 'The predictions about genet c interven on in humans are

"It's easy to visualize how enhancement of the regulatory genes," said Dr Richard Cutler, "could lead to a longer, more vigorous life."

vastly unrealistic ' says mo ecu ar b ologist Mark Ptashne of Harvard The prob em is that you have to change every cel n the body and there s no way of doing this Of course it is possible to alter the genetic makeup of certa n kinds of ce s say, red blood ce s, but that might not be any better than perform ng organ transplants "

Famed geneticist Joshua Lederberg, pres dent of Rockefe er Un versity, s less skeptica "You cou dn t just insert a genet ca y transformed ce l anywhere n the body and expect t to take over You d have to insert t in a su table pos t on so that it cou d be acted upon by the appropr ate mechan sms that regulate gene expression And we don t know how to do that yet "

Alexander R ch of MIT, agrees that we don t yet know enough about gene regu a t on to contemplate genetic eng neering in humans, but he is confident that such prob lems can be so ved "Right now we're at the point where we can ana yze the DNA in the human genome, find the genes that are not functioning properly, and figure out what to do to correct them. It s on y a matter of time ' he nsists, 'before we find out how to ntegrate such changes into the genome and get the corrected cells to funct on properly n the body."

For some gerontolog sts genet c inter vent on doesn t seem so far off Cons der the build ng of a better, long-l ved mouse for instance. There are severa ways b ologists might try to build one Most involve gene sp c ng techniques sim ar to those su cessfu y employed by Francis Rudd e s ab at Yale and Stanley Wo f s ab at Johns Hopk ns The techn que is to nject a mouse ovum with DNA supergene mate r al The materia cou d be a tered so that more effect ve regu at on (and possibly longer life span) resu ts In ject the ovum w th many copies of the supergene so that when it div des into an embryo every cel has many t mes the norma eve of protec t on and ability to repa r

A more diff cu t way to obtain greater protect on requires expos ng ce ls to tox c chem cals and bath ng them in po sons such as superoxide Only ce s that have exceptionally effective protection w ll sur v ve You cou d cont nue exposing them to higher and higher concentrations of toxins unt you have ce s that contain severa hundred t mes the norma eve of protec t ve enzymes centr fuge cel s In ject these nto mouse embryos. Gestate seven weeks and, presto, supermice

'Such genet c man pu at ons might prove to be d ff cult, ' Cut er disc a ms "If you get lots of mice with mutat ons n the MHC they m ght not be long ived, and the mutations might make t worse " And there are other compl cations

In agreement with some geronto og sts Brooklyn Co ege b ochem st Ro f Martin says ' We need evidence that exper menta man pu at on of th s supergene can in fact extend life span Correa t ons between the MHC and fe span do not yet show causa ity Someone must intervene exper mentally and perturb the evels of protec t ve enzymes l ke SOD and demonstrate that ongev ty s increased fe extens on, as accomp ished by Joan Sm th Sonneborn, is the proof of the pudding

But you can be sure, ' Martin says "that as soon as we obtain this ev dence, there w l be a great effort to increase the concentrations of protect ve enzymes "

Like other gerontologists Lipetz s ex cited about the congruent paths lead ng to the same genet c site Discover es are tumb ng over breakthroughs in qu ck succession Lipetz fee s the heat and has to step back for a minute to ga n an objective footing. Whenever gerontologists distance themselves from the research they usua y return to the same overr d ng thought: "We sc entists are coming very close to man pu at ng life span " Lipetz says 'We're tra ned to understand the mechan sms and to fig ure out ways to manipulate them We re not tra ned to handle the mpact that these d s coveries are going to have on society

"I have seen peop e who have very emotiona responses when the subject s brought up " he adds and the emotiona ty makes me cautious "

INTERVIEW

CONTINUED FROM PAGE 86

about twenty years before you've even got the energy back that it took to construct the thing.

Omni: What about putting the collectors on a satellite?

Gold. Oh, that's much worse. With a satellite you'd never get your investment back. It's reasonable, especially in sunny parts of the country, to do a first-rate job of water heating with fairly cheap solar panels on your roof. However, to think of making electricity or generating power is totally ridiculous. Methane is quite another thing. Even with the cost of deep drilling—

Omni: You keep saying that we'll have to dig for these methane stores, but doesn't natural gas occur along with coal and oil deposits?

Gold: The fact that so much of the gas thus far found has been found in association with petroleum is so simply because that's where people looked. The whole natural gas thing evolved in the first place as a by-product of looking for petroleum. I am convinced there are vast areas where petroleum is absent but where the gas may well be present. I can say this quite confidently now because even where methane is found over petroleum, it has nothing to do with petroleum. It's there purely because there's a cap that can hold both.

Omni: How do you know that methane has nothing to do with petroleum?

Gold: Anything that contains carbon, as methane and petroleum do, usually has two kinds of carbon isotopes, carbon-12 and carbon-13. The petroleum deposits in any one place have a certain range of carbon isotope concentrations, and the methane, even when it is overlying the petroleum, has a totally different ratio. No connection. A Soviet scientist, Dr. Galimov, wrote a paper saying each had a different geochemical history.

Omni: Then where does methane come from? Isn't it a fossil fuel?

Gold: No. The deep methane dates back to the formation of the earth, predating any biological activity on the planet. It seems to me that methane could be released as the carbon-containing meteoric materials that formed the earth are heated. Just as heated oven grease breaks down into liquids and gases. Another possibility is that there's graphite—just plain carbon—in the deep rocks. If you heat graphite and water, you will also make methane.

Omni: What makes you think so much carbon is coming out of the earth?

Gold: That's not my idea, that's common knowledge. The evidence is everywhere. Carbon is enormously concentrated on the surface of the earth, rather than down in the deeper rocks. Carbon clearly has to come to the surface as a gas. It is very important to know whether it's come up in oxidized form, as carbon dioxide, or in unoxidized form, as methane. Most geologists have assumed it all came up as carbon dioxide, out of volcanoes. Why? Because if you go to a volcano now and sniff what comes out, you find it's mostly carbon dioxide.

Well, I was immediately suspicious of that statement. The lava in a volcano has enough oxygen in it, and enough heat, to oxidize the methane to carbon dioxide. So the carbon dioxide coming out of the tops of volcanoes doesn't prove anything at all. It also seemed to me that if gases were trying to make their way out from the inside of the earth, it was very unlikely they would find their way to the few ranges of volcanoes. So I started thinking about cracks in the crust as exits for letting gases out. I said, Well, we have to look into the evidence for gases coming out of faults or in tandem with earthquakes. Has there been any anecdotal evidence of odor or flames during earthquakes?

Omni: Does methane have an odor?

Gold: No. But other gases that come from deep underground do. So I looked at the literature on earthquakes and found many mentions of sulfurous fumes, sometimes described as absolutely asphyxiating. There's also a fair amount of literature on lights in the sky at times when quakes occur. Could it be that methane is involved and that it catches fire? Then my colleague Steve Soter and I looked through detailed descriptions of a number of earthquakes and found them full of accounts of flames burning out of the ground, huge areas bursting into flame at the time of the quake, trees along a fault line being burned, cinders being found there the next day. No question that it was flames, you see. And this was true in areas where there was no knowledge of any petroliferous substance. If you're standing on top of an oil field you can say, Well, anytime an earthquake happens, there's going to be some stuff squirted up that will catch fire, but if you're in a place that has been drilled and found wanting, and flames shoot out of the ground, then obviously it's something else.

Omni: You think methane is responsible?

Gold. Yes, and moreover, there's a long list of phenomena known about earthquakes that can all be understood in terms of gases coming out, holding perhaps one of the most important points the fact that earthquakes deeper than five kilometers—and many earthquakes are deeper than that—really cannot happen except with the fluid pressure of gas or liquid in a lot of pore spaces in the rock. Otherwise, a sudden breaking, a crack slipping, which is what an earthquake is, would not occur. The stuff would always glue itself together under the overbearing pressure; a crack would never develop. And if you produced a large stress, it would just deform gradually and wouldn't make a sudden jolt. A sudden jolt requires that a gas rush into any crack as it is forming and have enough pressure to hold the crack apart. You understand that the crack propagates at the

tip like a sheet of glass breaking. As fast as the crack is propagating, a gas has to rush in and keep the fracture from mending.

I want to make it clear that I'm not giving you the gas as a reason for the earthquake but as something that facilitates it. If there is a big quake, then, of course, most of the pressurized gas down there will escape, especially at the moment when you've shattered the rock above. This means that if you want the possibility of making another earthquake there another day, you need a fresh supply of gas.

Omni: Does the frequency of earthquakes indicate a big supply?

Gold: Well, earthquakes are very common. I'm not talking just about in California or Japan, but even in the middle of nowhere. And if you think that in any one area you've got an earthquake every thousand years or so, that still means hundreds of thousands in recorded history, just to account for present day statistics, I have to supply regions at least thousands of times with a gas. And I cannot believe that only an initial supply of gas was down there and then only one thousandth of it, or less than that, escaped during the quake. There must be a continuous supply of gas to facilitate earthquakes in this way, and it must be making its way up from underneath.

Omni: What other indications do you have that gas is associated with earthquakes?

Gold: A number of precursors are known to be associated with earthquakes, though they don't always occur and it's not convenient to make sure predictions from them. Groundwater levels may change abruptly, and with that, the electrical conductivity of the ground also changes. Traces of gases like radioactive radon start coming out of the ground, and the velocity of sound waves in the ground changes a little before an earthquake. After an earthquake happens, these quantities often return to normal. All these effects can be understood in terms of a little gas having invaded the region.

Omni: How do you account for the Chinese reports of changes in animal behavior before an earthquake?

Gold: As the gas-filled region approaches the surface, ahead of it there's already a little leakage, coming right up to the top. The animals can smell it, and they respond to it.

Omni: If methane is odorless, what are they smelling?

Gold: Well, to animals, methane may have a smell. Anyway, for the most part they are just smelling the shallow earth gas being displaced and pushed up to the top. You know a pig is interested only in the smells in the first meter or so of soil, where it digs for truffles or something. A pig gets terribly excited if you freshly plow a field, because it turns up all these earthy smells. I know I used to work on a farm, and I remember a pig going what you might call hog wild when a field was being plowed, squealing and squeaking and going crazy. If deep gases come into the ground, the shallow gases get pushed out — gases from decaying vegetation and microbial processes, all of which have rich smells to animals.

Omni: Could sonic booms have anything to do with methane escaping?

Gold: Yes, I think various episodes have been due to the outgassing process. A bit of gas forces its way up, shooting up through cracks at enormously high speed because it comes from an enormous pressure, and it will sound like a boiler bursting. There may be a very loud bang, but only a small amount of gas can produce that. It will have come out of a little crack, and unless someone were standing on top of the crack, he wouldn't have known. He would simply have heard a loud bang.

Omni: Don't people tend to attribute these noises to trucks backfiring or some such thing?

Gold: Nowadays they do, but a hundred years ago they didn't. And there were plenty of cases in the old days of booming episodes in regions where there was no question they were natural, that they weren't man made. In some cases they did herald an earthquake. In San Francisco and Charleston, South Carolina, earthquakes followed a series of booms. In Charleston a very violent loud sequence of booming noises frightened people before the enormous earthquake of 1886.

I looked into a series of booming noises one winter and a large proportion of them turned out to be military aircraft that had failed to comply with the regulations and gone supersonic. In a few cases booms were produced by military aircraft out over the ocean where supersonic flight is permitted, but weather conditions had conducted the sound to the shore. Another clearly identifiable portion was from the Concorde. My colleague Gordon MacDonald analyzed this in some detail and concluded that about thirty percent of the booms had no sensible explanation in terms of aircraft. In any other historical era that thirty percent would be perceived as a very big series of booms. It's only now, when seventy percent are explained away as man made events, that people ignore the remaining thirty percent. And that, of course, is a very bad thing, because it means that we won't notice the most dramatic natural booming series. We will say "it's some more aircraft" or something. We'll never know.

It's also common to hear reports of huge areas of bubbling ocean and of massive fish kills (presumably the work of poisonous gas) in association with earthquakes. Rivers and ponds are often reported bubbling, not only at the moment of the quake but at surrounding times.

Omni: Have you published your theory about methane outgassing?

Gold: Yes, in the *Journal of Petroleum Geology*. A long paper in February 1979. And an article I wrote with Steve Soter in the June 1980 *Scientific American*. I have done

a lot of homework, and I know a lot of relevant facts but I think the response in many government quarters was "Oh, well, we've heard that kind of stuff before, and it's turned out to be nonsense and we don't want to listen to it anymore."

Omni: How have geologists responded?

Gold: Some favorably, some violently opposed, some sarcastic. Here's some correspondence I had with a geologist who wrote a sarcastic letter to the editor of the journal in which my work appeared. I wrote him one of my funny poems. I like to write humorous poems. My feeling is that I can persuade any earth scientist of the *reasonableness* of my case, if he's willing to listen for a couple of hours. I won't say I can persuade them that my case is right. Quite a number of people are already persuaded. But not enough.

Omni: So you are embroiled in controversy again, aren't you?

Gold: Yes, and I am confident I'll be proved right this time. My trade is finding right explanations for all types of phenomena, on the earth or in the astronomical sky. I make it my business to understand anything that's a bit complicated. I claim that when I speculate, my speculation is always based on a large amount of data and on a very substantial discussion. It seems people don't understand that in speculation there's good and bad, and if one wants to be better than average one just has to understand a lot of facts and comprehend basic physics. So many people have the idea that if something is speculative, it's anybody's game and anyone can speculate as well as anyone else. That is a very silly attitude.

Omni: What other speculations of yours run counter to popular thinking?

Gold: There is much discussion just now about volcanoes on Io, a moon of Jupiter. The *Voyager* spacecraft discovered these enormous plumes there, which are thought to be active volcanoes. But I don't believe that. I believe they are places where big electric currents churn into the ground.

A very large current, five million amperes, runs through Io because of its motion in the magnetic field of Jupiter. We know this. I believe that what happens is that the current focuses down on a few spots where it runs into the ground, it's just a sort of permanent lightning. And of course it evaporates everything there. So it makes it very very hot on the surface and anything would boil, rocks and all. A shower is created that sprays upward, and this is the reason why these seven or eight so-called volcanoes are blowing off incessantly. They aren't volcanoes at all. I have a paper on this in *Science* magazine.

Omni: What made you suspect the plumes weren't volcanic?

Gold: Material from the eruptions is thrown to a height of more than two hundred kilometers, and if you work out the speed at which it has to be expelled to reach that height it turns out to be faster than one kilometer a second. You can't expect volcanoes to accelerate sulfur fumes or any of the other substances on Io, to anything like that speed.

Omni: Have you at least ended the controversy over the steady state theory? And do you now accept the big-bang explanation of the universe?

Gold: No. I tend to think that we don't know. I've always regarded the steady-state theory as an excellent theory against which to compare observational data because it's so clear-cut and clean. The simplest version of it, however, now appears not to be justified. But it's perfectly possible that some other version will be found correct. At the moment I'm thinking of what the steady state theory would be like if one assumed a great deal of unevenness in the distribution of the universe. There seems to be a lot of evidence now that the universe is very lumpy, enormously lumpy. And if it's enormously lumpy, well, that could give you results that would appear to be discordant with a smoothed-out steady-state theory but perhaps not with a lumpy one.

No, I won't say I've changed my mind. I've always stressed the steady-state theory as the most testable one, but it should not be a matter of belief. I don't for a moment claim to understand enough of cosmology because not enough is known and there could be a lot going on we know nothing about. It's quite different from having a firm opinion on some physical effects. You can be right or wrong, and you can own all the data it takes to be sure you're right. In cosmology we have as yet no idea of the data required for us to be sure.

Omni: What was the most satisfying argument of your career?

Gold: I suppose the pulsars. That was the nicest, and it was a good, clean race, because everyone had his toes on the starting line at the same time. The same information was available to everybody.

At first, everybody thought pulsars were pulsating white dwarfs. The first pulsar conference was held in New York in May of 1968, and a few months later my rotating-star story was, of course, universally accepted. But in the two day conference I asked for five minutes to explain why I thought that was what they were. I had a perfectly good list of points, and I felt they were so strong there was no doubt. But out of the two days I was not given five minutes. I had to make my case by just demanding time from the floor.

Omni: What happened to persuade the others?

Gold: The discovery of a pulsar in the Crab Nebula had predicted that places like the Crab Nebula would have pulsars in them, that they would be pulsating the fastest, and that they would be slowing down. And the Crab was a faster pulsar than any other, and it was immediately seen to be slowing down. The fact that it was in the Crab meant that a supernova had given rise to it, and all that fitted the neutron-star model. And that really clinched the matter.

"You can inform the American public that the scientific community is not quite finished with the testing of saccharin."

YOUR EYES ONLY

CONTINUED FROM PAGE 52

Navy once again hopes for a planetwide submarine communication system, and we can expect new proposals very soon.

The Center for Naval Analyses has an intimate relationship with its sponsor. Because it serves primarily only one client it has a great degree of influence. Employees of CNA go to sea on naval vessels to perform operational tests and evaluate equipment, personnel performance and shipboard procedures.

The Naval War College where young officers on their rise go to get one of the holes in their career tickets punched has CNA people assigned to its staff on a rotating basis. The college serves an important function in the Navy and civilian analysts play a role in shaping future admirals.

Not all the Navy's top brass appreciate everything that the CNA tells them. One revealing incident occurred in 1974, just after I attended a lecture at the CNA auditorium. It focused on how computers, if programmed to be sufficiently "smart" could take over the weapon firing function of a ship's guns and missile launchers. The talk was peppered with references to artificial intelligence, specific computer technology and other esoteric matters.

Many of the captains and admirals present who had served during the period from World War II through Korea balked at any suggestion that machines would replace men in the weapon-firing decision process. They wanted to shoot the doggone guns themselves. How, after all, could you bark orders at a computer?

Later I rode in an elevator with a couple of admirals. Not knowing either of the gentlemen I stared at the ceiling and listened to their evaluation of the seminar. One of them, a rugged, tough looking fellow who could have been a twin of James Cagney playing Admiral William Halsey, summed up his reaction with a scowl and the immortal words: "All of these goddamn theoretical analyses are taking the humanity out of warfare."

The CNA, because it has but one sponsor sometimes has problems in remaining objective. It remembers too well who butters the think-tank bread. If the broader based, liberally funded DIA thinks a program stinks it can say so without fear of reprisal. The CNA usually can do so, too, but not in every situation.

What might military think tanks be working on right now? The best guess would be the Cheyenne Mountain fiasco of last June. That was when NORAD's computers in Colorado Springs hiccuped and alerted our sentries that the Russians had launched hundreds of missiles against us. The B-52s of SAC and our land-based ICBM crews immediately went on alert. It was a mistake, fortunately, and the Defense Department has probably funded a tank study to determine what should be done to avoid more such goose pimply episodes.

Let's toy with something just a bit more daring. Think back to the opening thoughts about personal targeting of leaders. There is no question that the technical means for such activities are close at hand. We have long been able to put surveillance satellites in orbit that can photograph and resolve the license plates of cars in parking lots. Certainly the Russians can do the same and they no doubt know where even the most insignificant junior lieutenant leaves his car each day outside the Pentagon.

How hard would it be to add some smart electronics and optics to the satellite, program it to recognize any given license plate and then drill a laser hole through the head of whoever gets out of the car? Or just incinerate the entire car?

There would be political considerations to be sure. But some think tank political scientist might be able to show that world opinion wouldn't find such a tactic reprehensible if the target were carefully chosen. Ruhollah Khomeini, perhaps. Project DIRECT ACCOUNTABILITY might even be perceived as a meritorious endeavor. As long as it didn't get out of control, of course.

Sound farfetched, crazy, impossible? Maybe. But think about it. You can be sure the military think tanks already have. ∞

TEN BEST GAMES

CONTINUED FROM PAGE 106

Bowling, Baseball, Sea Duel, and *Star Phaser Trek.* If you like deductive games and solving problems in a minimum number of moves, consider the *Mind Bender* and *Connect Four* cartridges.

Personally, we prefer the eye-hand coordination games and believe that the very best cartridge for Microvision is *Block Buster,* which luckily, comes with the basic unit. This is a downsized version of *Breakout,* one of the most popular arcade games ever (before Space Invaders). You move a paddle across the bottom of the screen, bouncing a ball back and forth against a brick wall at the top of the screen. The more times you hit the wall, the more the wall crumbles and the faster the ball moves (and the more points you get). Eventually you can send the ball through a crack in the wall and it bounces around behind the wall, racking up points. There are other companies with hand-held variations of the *Breakout* theme, but we judged Microvision the best with the most play-it-again appeal. A nice feature: It beeps to tell you to turn it off if you forget. From the folks who brought you *Simon, Super Simon,* and *Big Trak.* For more information, write Customer Service Department, Milton Bradley Company, 443 Shaker Road, East Longmeadow, MA 01028.

6. TENNIS (Tomytronics, $45)

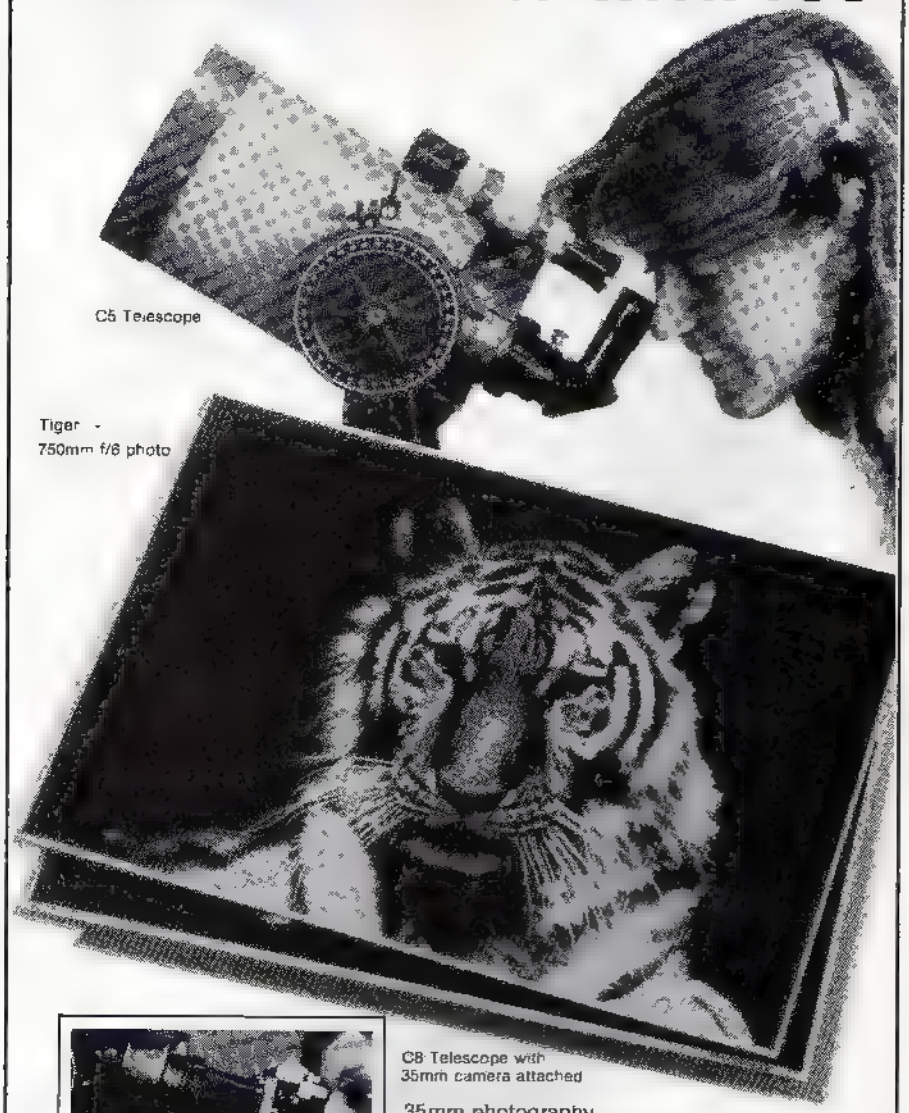
Three features helped put this game on our list. First, in a field where all the major physical sports – football, baseball, basketball – have electronic analogues in profusion, it's nice to see something different like tennis. Second, the fluorescent visual display on this is excellent: The little figures actually look as if they are swinging tennis rackets, and the ball follows parabolas almost as if it were being affected by gravity (still less effective than Atari's *Basketball* cartridge in this regard, however). Third, Tomy *Tennis* has a practice mode to let you get used to the timing of your swing before you start worrying about positioning your player in the proper court. We judged this to be a big plus because this game is quite difficult to learn. More games should include an extremely simple practice mode to give first timers an idea of what's going on. If a game is too hard to pick up, people will put it down.

Tennis can be played solitaire against a computer-operated player or head to head against a human opponent. Tomy Toys is at 901 East 233rd Street, Carson, CA 90745.

7. BASKETBALL (Bambino, $35)

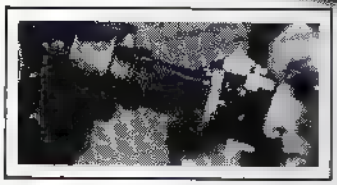
Bambino, the Japanese company with the Italian name, has to be given credit for some of the most beautiful designs in electronic gaming. The consoles are colorful and streamlined, a pleasure to hold. Bambino's fluorescent dot-matrix displays are visual treats. Instead of letting you push a

YOU CAN TAKE IT WITH YOU



C5 Telescope

Tiger - 750mm f/8 photo



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co ored LED rectangle aroJnd and pretend it s a quarterback or a goa ie or a race car Bambino gives you figures that begin to look like the rea thing

The v sual display in *Dribble Away Basketball* is as good as they come You re the offensive player try ng to get past defenders (three to five of them, depending on adjustable skill level) Start the 24 second clock set your ball control to dr bb e low med um or high, charge past defenders, jump, shoot! Defens ve players jump to block shots and all p ayers move their arms and legs The game has drawbacks t is difficult to learn, the offensive player s a one w th no teammates to pass to and there s no way to control the action of the defensemen, but the real sm of the display is enough to compensate for game mita-tons Bambino, nc , is at 2049 Century Park East Los Angeles CA 90067

8 FIREMAN, FIREMAN (Mego $35)

What can you say about a game in which the object is to catch people who jump from a burning bu ld ng then bounce them three times on a fireman s net and into a wait ng ambu ance? Yes, t's sick, crazy, weird and absolutely compe ng *Fireman, Fireman* s part of a ne of miniature electronic games (about the size of a stack of credit cards), wh ch Mego calls the *Time Out* series The games are perfect for carrying in a pocket and for play almost anywhere n *Fireman, Fireman* you have to keep bouncing a series of babies (the book et calls them "evacuees," but they look ke bab es) sometimes keep ng as many as f ve in the air at once, catching one on the f rst bounce sh ft ng to get another on its third bounce then back to pick up the first before it takes a second bounce, etc Drop one and a tt e angel appears Three angels and the game s over

Other *Time Out* min-games, *Toss Up* (juggle two or three ba s unt l you drop one) and *Exterminator* (another s ck e — a tt le man with s edgehammers bops moles over the head as they pop out of holes)

These games have two other unusual features that make them unique. (1) Each s also a dig tal c ock The ow-energy LCD display continues to show moving characters even when the c ock is displayed and the game is "off" The constant motion adds to its pick-me up qual ty (2) The game retains in its memory the highest score atta ned on it so far. That's fine if you want a lasting record of your superiority and it a ways g ves you a goa The memory can be erased by resetting the c ock

9 ACE OF ACES (Gameshop $13 95)

This is World War I air combat simu at on and one of the most orig na game ideas to come along n years

There are two books *Germans* and *Allies*. Leaf through the *Germans* book and you ll see sketches showing hundreds of views from the cockp t of a Fokker DR1 tr plane with a menac ng Sopwith Came flying n the d stance. The *Allies* book shows complementary views of the Fokker as seen from the Came P ayers privately choose a flight maneuver (from 25 possible) look up key numbers, then turn to new pages that show the planes in their new relat ve pos t ons When the enemy s in your sights, shoot The closer he s, the worse the damage and the more points you get Devotees play repeated y as different pilots, gaining experience points, which are f gured into s ccceding games

What a great idea a war game you can play anywhere, even over the phone! In a few years we ll probably see this game on a video computer screen. The player s eye-v ew d splay w probably be appl ed to other electronic games before ong What will electron c baseba l be like when n-stead of looking down from the Goodyear b mp, we ook at the d sp ay from a batter s eye view?

Ace of Aces s ava able direct from Gameshop, nc 46 Dougherty Street Manchester, CT 06040, for $13 95 p us $1 40 for ship pp ng and hand ng (tota $15 35) Connect cut res dents must add 7 5 percent sales tax

10 CAN'T STOP (Parker Brothers $9 25)

To give some ba ance to our st, we looked at new board games, nclud ng such excellent ntroductory war and fantasy games as *Cosmic Encounter* (Eon) *Junta* (Creative Wargames Workshop), *The Awfu Green Things from Outer Space* (TSR Hobb es) and *The Creature That Ate Sheboygan* (SPI)

What we finally settled on was s mplic ty a compell ng board game cal ed *Can't Stop* that works well for two players even better for three or four You ro four dice and combine them n pairs to get two numbers (a roll of 6, 5, 2, and 1 could give three possible pairs 11 and 3 8 and 6, or 7 and 7) You place wh te markers on the board n the co umns correspond ng to your chosen numbers or move up markers that are already there, trying to reach the top of three columns and cla m them You work up to three co umns at a t me, and as long as you can produce one of those three numbers from your rol of the dice, you can e ther ro again or stop and replace the wh te markers w th your colored tokens f you can t move a white marker you ve b own t and must remove a three of them, without p ac ng any of your colored tokens on the board The probab l t es of rolling various pa rs map nicely onto the octagonal Stop sign 2 and 12 are the scarcest pa rs and there are only two steps to the top of those columns The most probable numbers fal in the long center columns An e egant game with an apt t tle nvented by veteran gamesmith Sid Sackson

THE HAND-HELD FUTURE

At times n the preparation of this report our off ce looked like a *Toys R Us* warehouse Examining a these games made us wonder what miracles we see next

The easiest prediction to make is that

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what has happened in the past will happen again. After *Space Invaders*, one of the most popular new arcade games is *Asteroid*, and we expect it won't be long before you'll be able to play it on your TV set, and then in your hand. The largest category of electronic games today is simulations of popular sports (baseball, football, hockey). There will be more in the future with voice synthesizers to call the play-by-play ("Strike one!" "Second down three yards to go") and improved memories to hold information about games even after they have been turned off. Development will be especially rapid on the games that have just recently been attempted in hand-held versions, especially golf (Atari), pool and billiards (Parker Brothers), tennis (Tomy and Entex), and juggling (Mego).

We see four major developments in the future that, once achieved, will drastically affect the games people play. First will be the introduction of player's-eye-view games, using programs now hinted at in the book game *Ace of Aces*. Second will be the introduction of three-dimensional play. We expect that the first of these will probably be an analogue of handball (just as *Pong* was revolutionary as a two-dimensional handball).

As display screens improve, you'll be able to watch a 3-D game on your 2-D screen—something like watching a tennis match on your TV set now. Someone will probably try a red-green display that will look 3-D when you wear special glasses. Simplified versions of chess and checkers will also be available in three dimensions. You can play 3-D ticktacktoe now; soon there will be programs playing in the fourth dimension and higher.

The next major step will come when programs are developed to simulate the motions of a background medium, such as air or water, and the reactions of objects in it. Then we will see a whole new class of electronic games: sailing, whitewater canoeing, surfing, hang gliding, boomerang. Frisbee. Atari's *Sky Diver* has a fair simulation of wind now, but there can be much improvement. What a great way to learn the principles of sailing! Change the angle of attack, the orientation of sails and rudder, and watch what happens. How long before the first America's Cup video game?

Finally, the ultimate game will be setting the machines to compete against each other. Milton Bradley has a programmable tank called *Big Trak*, a sophisticated toy. But with two units and a roomful of obstacles, *Big Trak* becomes a game. Who can program it to go the farthest without running into something? As robots' skills and versatility increase, their creators will naturally enter them in competition. We'll see robotic versions of track-and-field events and competitions to find the best window-washing or drink-mixing robot. Who will develop the first machine that can catch a ball or throw a ball and hit a moving target? When will we see the first Robot Olympics? ☐☐

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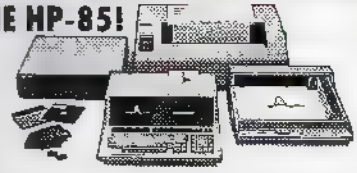

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GAMES

ANSWERS TO GAMES (PAGE 152)

1. The letter *h* (A silent *h* is most often in *heir* and dies in an *hour*.)
2. Cares—caress
3. Today
4. Manhattan. ("My first" in such charades refers to the first syllable, "my second" to the second syllable, etc.)
5. Dodecahedron. A twelve-sided solid. anagram of "no hard decode."
6. The letter *m*
7. Co-run drum
8–9. Woman

Trying to distinguish among an enigma, a charade, and a riddle can be a puzzle in itself. The definitions of all three overlap, but there are narrow differences. Enigmas and riddles are related because they generally describe whole ideas. Charades separate an idea into parts. An example of a charade would be the clues "uncle" and "an" for the answer "unclean." To get the same answer in a riddle or an enigma, you might use the clue "dirty."

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MIND

CONTINUED FROM PAGE 30

genuine danger to victims' bodies.

Dr. Beverly Paigen, a cancer researcher who presented an assessment of the health hazards at Love Canal to a House subcommittee in 1979, says that the emotional situation is overemphasized; that neurotoxins may be largely responsible for abnormal psychological behavior among the people of Love Canal.

She found that in addition to chemicals capable of causing cancer, miscarriage, birth defects, and urinary and respiratory diseases, at least 36 chemicals found in the dump site are potential neurotoxins. Indeed, severe headaches, pain in the extremities, tingling, blackouts, hyperirritability and epilepsy have been common complaints among those who lived around Love Canal. Many of the children are slow learners, often diagnosed as having minimal brain dysfunction. Others, according to Dr. Paigen, are hyperactive, capable of bizarre behavior and sudden personality changes. Among all residents, data on nervous breakdowns and suicides are limited, but Paigen points out that in wet or exposed areas the numbers are higher than in the dry areas of Love Canal.

Some help is available. For instance, Dr. Richard Valinsky, of the Niagara Falls Community Mental Health Center, is coordinating a counseling program for the United Way.

"What we see more and more is a loss of faith in government," he reports. "Residents see a lack of response to their need to get out. With that need frustrated, the demand for counseling has increased."

"From the mental-health standpoint, the most important thing is to move the victims of these situations out. Immediate permanent relocation is highly desirable."

Sister Margeen Hoffmann, another Love Canal volunteer and members of her Ecumenical Task Force offer practical and spiritual advice to anyone who wants it. A veteran of several natural disasters, she believes in "justice to the victim through understanding and reconciliation."

Sister Margeen notes that in a natural disaster the disruption of lives is followed by a heroic honeymoon period, when rescue workers and aid pour into the devastated area. "At Love Canal," she says, "we never had the heroic honeymoon period. We have always been in a period of deep disillusionment."

The disillusionment has its price. Sister Margeen says that she had never before seen so many pills as she saw among the uprooted motel bound Love Canal families, among whom serious domestic problems have become commonplace.

"Their stamina and resiliency are tested every day," she states. "When anyone comes in and shows concern, the people think maybe this is the Moses who will lead us to the Promised Land."

PEOPLE

By Dick Teres

Psychologists at meetings do things that other professionals would shy away from, for fear of what people would make of their behavior psychologically. The annual convention of the American Psychological Association (APA), held this fall in Montreal, was filled with behavior rich in such imagery and symbolism.

Leon Festinger, for example, of the New School for Social Research, chain smoked through his invited address, "Can the Science of Psychology Address the Question of Human Nature?" **Bernie Zilbergeld**, of Oakland, California, who is catapulting to fame for having attacked the sex therapy of Masters and Johnson in *Psychology Today*, smoked his pipe and crumpled papers while other panel members at his symposium held the floor. And **Philip G. Zimbardo**, of Stanford University, arriving late for a symposium at which he was to speak, came up behind fellow participant Arnold H. Buss of the University of Texas at Austin, threw his arms around him and kissed him.

Most quotable speaker at the convention was none other than **B. F. Skinner**. Some sample Skinnerisms:

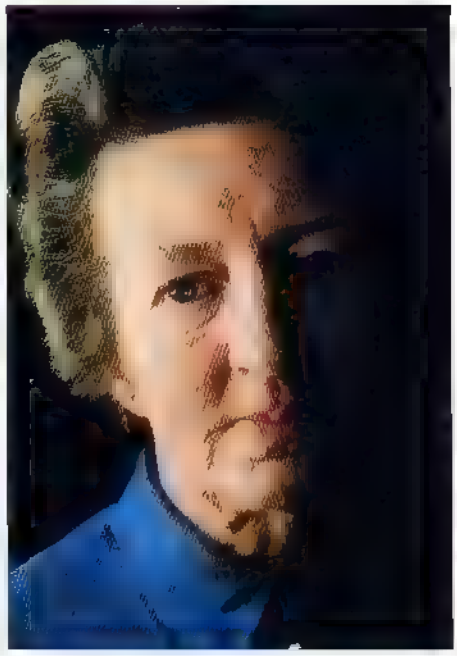
- "I've often said that my rats have taught me much more than I've taught them."
- "The rat is always right."
- "Someone asked me yesterday how I could keep going on when people so misunderstood me. I said it's all a matter of scheduling. All I needed was to be understood once a year."

B. F. Skinner: "The rat is always right."

Another star of the convention was **Hans J. Eysenck** of the University of London. Eysenck told about a little behaviorism (systematic desensitization) he once applied to himself: "My fear of spiders didn't bother me until I was courting my wife, who was more afraid than I was. So I read books about spiders, looked at pictures of spiders, caught flies and fed them to spiders, and finally I got to like the damn animals."

Donald O. Hebb of Dalhousie University in Nova Scotia regaled the convention with anecdotes about **Ivan Pavlov**, the pioneering Russian physiologist famous for his work with dogs and the conditioned reflex. Hebb told of a colleague, **Boris Petrovich Babkin**, who had worked for Pavlov collecting gastric juice from a dog. "The dog was bored and whined," said Hebb. "In the next room I was Pavlov trying to write a paper. Suddenly through the door came Pavlov with towel in hand which he used to whack the dog over the nose, telling it to shut up. Back to his room he went. . . . Then he was back again, shaking his finger in Babkin's face and saying sternly, 'Babkin! Never strike a dog! Never, never, never!'"

In the convention's pressroom, one veteran reporter was heard to say, "I'm just resigned to it by now. The only psychologists I count as friends are the ones I've never written about." And a final comment from a taxi driver who had been hauling APA conventioneers around all week: "How many psychologists does it take to change a light bulb?" [Answer:] "Only one, but the light bulb has to *want* to change."



Mary Leakey: One more time for the cameras.

Meanwhile, on the archaeological front, **Mary Leakey** revealed some of the not-so-spontaneous aspects of scientific discovery in a recent interview with *Omni* reporter Susan Mazur. Retelling the story of the finding, in 1959, of the *Zinjanthropus* skull, Leakey explained how she and her late husband, Louis, actually made this pivotal discovery in Africa's Olduvai Gorge *twice* — once for themselves and once for the cameras. Leakey described it, "I was prospecting. My husband wasn't feeling well. I saw a bit of bone that looked strange. It was, in fact, the mastoid of the skull. And when I brushed some soil away, I found some teeth, which showed it was hominid straight away. So I fetched my husband away from camp. . . . And we were very fortunate because Les Bartlett, a professional photographer, was to come down. So we covered it up and waited till he arrived two days later. We have a film now of the whole uncovering of the skull, which is very fortunate." Proving that even in 1959 some scientists were already conscious of their roles as media stars.

EXPLORATIONS

By Susan Mazur

Seasonal rains teem on downtown Lagos. The humidity produces a kind of fever. You are reluctant to breathe. The streets are pocked with quagmires of mud. If you miss a step, you land in an open sewer. The only opiates for the rawness of the place are the colorfully wrapped women who sell peanuts, cola nuts, and fruit in the marketplace.

"Briefly put, our towns and cities are almost without exception inhuman," Nigeria's *Sunday Times* says.

But this is not going to be the Nigeria of tomorrow, or, as Nigerians like to say, "the day after tomorrow." With Alhaji Shehu Shagari, a former science teacher, as the first democratic president of the country, Nigeria is moving to meet the future by developing an infrastructure based on science and technology. And with the wealth of 20 to 40 more years of "petro-nairas" fueling its plans, Nigeria will rival Western industrial countries in modernity and creative design.

For starters, Nigeria has allocated several hundred million nairas ($1.80 = 1 Nigerian naira) to move its capital from Lagos, on the coast, to the center of the country. This city of the future, at Abuja, will serve as the new seat of government by 1982 and will bring greater coherence to the estimated 100 million people (predominantly of the Yoruba, Ibo, and Hausa-Fulani tribes) sprawled over an area one fifth that of the United States.

Part of the appeal of the 7,800-square-kilometer site is its beauty. Bordered by hills to the north, east, and south, the terrain is savannah—tall grass, trees, and soft undulations of the landscape. Year-round temperatures vary from 21 to 26 degrees Celsius. The breezes are gentle and clean. And the Niger River is just 24 kilometers away. It is said that Abuja will pick up where Brasilia, Brazil, and Islamabad, Pakistan, left off and that of all the great cities of the world only Florence, Venice, and Stockholm were as imaginatively planned.

Abuja will meld the best elements of Nigeria's past and present. Architecturally, it will draw from civilizations like the Benin, which by A.D. 1400 had evolved into a highly developed culture.

Nigeria's next generation will benefit from their government's commitment to the future

And there are the Nok, a people of mysterious origin that flourished from 900 B.C. to A.D. 200 as the first Iron Age culture in sub-Saharan Africa, then disappeared, leaving behind caricaturelike sculptures of terra cotta human and animal figures with triangle-shaped eyes.

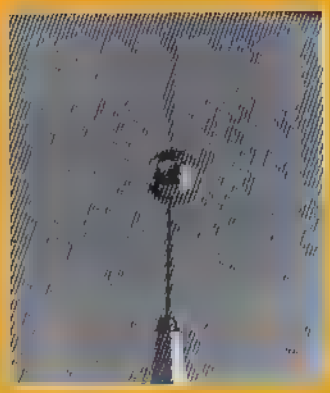
To infuse life into this dream of Nigeria reborn, the Ministry of Transportation will undertake the development of a new physical network: a standard gauge 166-kilometer-per-hour railway system that will criss-cross Nigeria, facilitating the movement of domestically manufactured goods and passengers; four major two-way highways to be utilized for the distribution of agricultural products; a half dozen international airports and 20 domestic airports; three ocean terminals to service Nigeria's fishing, steel, and shipping industries.

Harvard-educated Dr. Sylvester Ugoh says the immediate goal of his year-old Ministry of Science and Technology is to see that by the turn of the century at least 50 percent of Nigeria's exports—exclusive of crude oil—are of industrial goods and that there is self-sufficiency in food production. "Science and technology are going to preempt everything," Ugoh says.

But there are a multitude of hassles here," reports Ron Parson, science officer at the U.S. Embassy in Lagos. While there are tens of thousands of young Nigerians who go abroad each year to study, including many in the sciences and at the doctoral level, not enough return to Nigeria, having found the standard of living abroad more attractive. This has created a dearth of qualified people—especially lab technicians—in Nigeria's work force. The nation's literacy rate is a mere 25 percent. Yet the government has decreed that Nigeria's industrialists and businessmen must adhere to a quota of 5 foreigners to every 1,000 Nigerian citizens hired to work in factories and shops.

These snags give rise to situations like a medical factory shutting down production for two to three weeks because someone forgot to order raw materials. There are regular interruptions of the telephone service and of the power and water systems.

NEXT OMNI



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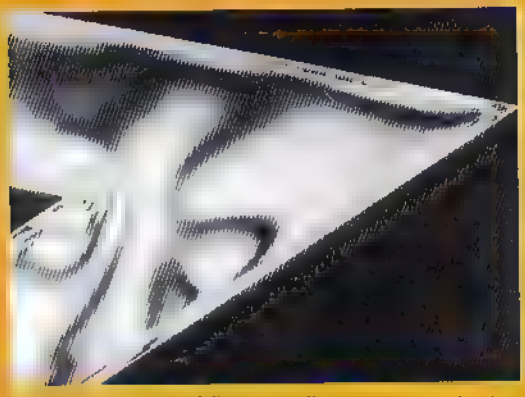

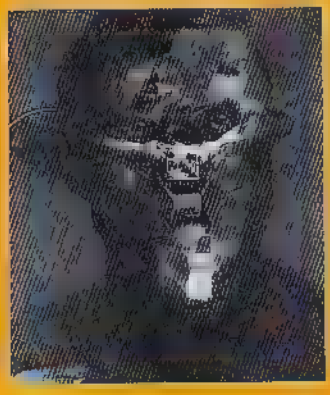

PRIZEWINNERS [illegible] FICTION

FUSION—The energy secret of the sun itself. Is fusion the ultimate solution to our energy problems, or is it the quixotic excess of rampant technology? For 30 years the physicists of many nations have tried to duplicate the searing conditions that exist in the heart of a star. Now they claim success is near and that limitless energy lies almost within our grasp. What will a fusion powered world be like? Who will profit from fusion energy? What are the political payoffs of this compelling energy dream? Next month's *Omni* examines the fusion story in full: its promise, its problems, and the people who are striving to harness the infinite energy of the stars.

TESLA POWER—The shortest route to practical fusion may be a tour through technological history. Robert Golka claims that inventor Nikola Tesla, who pioneered our AC electrical system, may have been on the right track in 1899. Tesla made artificial ball lightning, the rare spheres of electricity that inspire many UFO reports. Golka has just duplicated Tesla's work and thinks he can build a fusion generator within five years—if only the Energy Department will give him the chance.

INTERIOR VISION—A gallery of paintings by Ernst Fuchs reveals the genius of visionary art in *Omni*, next month. A leader in the Viennese school of Fantastic Realism, Fuchs explores the human condition sublogically, through hypnotic images of great intensity and strangeness. Fuchs takes the viewer into a hallucinatory realm that combines mystic allegory with a disquieting perception of man's future condition. Don't miss this portfolio of spectacular conceptions in the January *Omni*.

PRIZEWINNING PHOTOGRAPHY—The best of nearly 6,000 entries reflect the amazing talents of *Omni* readers as we present the results of our first photography invitational. The most accomplished effort, our Grand Prize winner is showcased in this issue on pages 150 and 151. Other skillful submissions from around the world make up a stunning pictorial of phenomenal sights in the January issue of *Omni*.

SCIENCE FICTION—A tale about a man so obsessed with dying that he constructs "A Cage for Death" highlights *Omni*'s January fiction. John Keefauver's hero in "Body Ball" searches for the ultimate gamble, and a scientist in Bob Buckley's short story "Where No Man Goes" races against time to fulfill a recurring dream.

which visitors to Nigeria know only too well.

Parson views the quota as ultimately beneficial because he believes it will lead to a large, competent sector of industrial technicians in 20 years. As more Nigerians return from schools abroad, Parson predicts, significant progress will be made in the Nigerian sci/tech infrastructure by the year 2000.

Dr. Felix Oragwu, a nuclear physicist and probably the single most knowledgeable scientist in Nigeria, says it's Nigeria's aim to accelerate critical research in its 23 institutes (agricultural, marine, projects development, industrial, forestry, leather, and others) and 13 universities. He mentions a plan to introduce science in the elementary grades. By offering such aids and incentives as more relevant texts, correspondence courses, TV programming, and science fairs with cash prizes, Dr. Oragwu hopes to graduate three college students in the sciences to every two pursuing other areas of academic study.

Considering the high rate of literacy, Nigerian television is an especially crucial means of communication. It steers clear of the predictable superficiality of American television, preferring to let viewers enjoy enlightenment and entertainment in the form of energetic dramas and spontaneous comedies. For example, next month Nigerian filmmaker Eddie Iroh will air the first of a ten episode science series, *Portrait of a Culture*, whose purpose is to create a new frame of reference for Nigeria's rich civilization. The first installment will open with a man and his son taking a cultural holiday. As episodes proceed, they'll explore several archaeological excavation sites.

There is an eagerness among Nigerians not merely for a better tomorrow but for an exceptional tomorrow. You can see it in the enterprise of the markets, with exuberant vendors on the highways selling everything from medicine cabinets to hard to get copies of American magazines. You can see it in the hotels, where waiters wheel and deal with international businessmen while serving them coffee. If Nigeria can continue to channel this spirit into producing more relevant technology for its people it will inspire Africa and the developing world and lend new direction to the developed world as well.

IN TRANSIT

For the smoothest transition between cultures, Nigeria Airways offers direct nonstop flights two times a week between Lagos and New York aboard a McDonnell Douglas DC-10. Nigeria Airways is the largest African airline and is third in the world in its record of safety (Nigeria Airways, 15 East 51st Street, New York, NY 10022). Close to downtown Lagos, the Eko Holiday Inn on Victoria Island, overlooks romantic Kuramo Waters, where Nigerians still pole their way across in small boats. (For more information about Holiday Inns in Africa, contact Holiday Inns, Inc., 3796 Lamar Avenue, Memphis, TN 38195.)

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FILM

CONTINUED FROM PAGE 34

Alan Kaprow, waiting endlessly at a bus stop in downtown San Diego, recites a Platonic dialogue in English. But most of Hock's films examine the structure of certain processes by speeding time up.

The quasi-scientific, "documentary" nature of his films—the degree to which they literally document things—has been noted by several reviewers. One of them, Mitch Tuchman, says that Hock's *Studies in Chronovision* "gauges nature's clocks by one of man's," adding, parenthetically, that the motion picture camera measures time, too: twenty-four frames per second.

Hock recalls that when he was setting up his camera on the fiftieth floor of the Sears Tower for *Picture Window*, he was a bit unnerved to find three men in gray suits standing directly behind him. "They looked really serious, as if they were going to throw me off the building. It turned out that they were trying to figure out how much the building swayed in a strong wind and were hoping they could use the camera to find out."

The Mirror and the Window (1978), another triple-screen work, takes the unusual approach of creating a kinetic close-up portrait of Hock in Del Mar, California, produced by filming his own face a frame at a time, every morning and evening, over a ten-month period.

"I was always curious, you know, about the vanity that prevails in the morning when you look in the mirror," Hock says wryly, "and in the evening when you say 'My God, I'm fat,' or 'I'm skinny' or 'I'm ugly,' or 'I look healthy' or 'I look tired.' I always thought that you could chalk this up to vanity, that men's faces are pretty stable."

But as it turns out, there's an immense plasticity that the face goes through. It's like some kind of modeling clay contorting around. The neck is a twisting snake, the jaws raise and lower like drawbridges, and the eyes turn around in their sockets and squint." It takes only six or seven minutes for this ten-month process to be viewed.

Like his own films, Hock is strongly environmental—often reflecting whatever terrain he happens to be passing through. "People keep going to theaters and seeing movies about things that are far away. The films themselves are distant, like games. And I get tired of showing my films in small rooms to the same audiences, the sort of circuit that an independent filmmaker does: show and tell, with a straw hat and a cane, around the country."

"That's why I like to show *Southern California* in outdoor environments," Hock adds, becoming eager again, "so that people have access to it." As an exhibitor of his own films, he is already "scouting" diverse locations for this project, from New York to Santa Fe to Berkeley, in the course of his travels, hoping to find places where his experiments with time can become natural parts of the scenery. ∞

RECORDINGS

CONTINUED FROM PAGE 32

Todd shrugs good-naturedly. "I never really knew, since I was relying on Peter Sinfield in London for news, Robert Sheckley having also vanished somewhere in Malaysia. Peter was recording his part in a London studio, learning to say *extraterrestrial exploration* without omitting the consonants."

Eventually all the elements coalesced, and by then Watson-Todd was battling deadlines toward his goal of unveiling the album at the 1979 World Science Fiction Convention in Brighton, England. "The printers gave me just thirty copies before they closed shop for their annual vacation," he recounts ruefully. "Those copies were snapped up, and orders for more came in at a brisk pace."

"I'm in an odd spot with this thing," Sheckley confesses, shifting self-consciously in his chair. "Maybe I just don't have a decent appreciation of selling things as art objects because that's not why you write stories. In a way I even prefer to publish in paperback. I figure eight bucks for a hardcover is a lot."

Despite certain qualms about his initial foray into multimedia, the author remains optimistic about combining narrative and musical forms. "I think there's a great future for such multimedia projects," he says. "It doesn't have to be an elitist limited edition either. There's room for such things on a popular level. Especially now, when all the forms are loosening up and more possibilities exist for combined media forms."

"I don't see why, for instance, a composer and a writer couldn't work together and produce something that is more of a mixture of the two forms. Something that would go on a disc and be right for the spoken word, rather than a story simply placed into spoken word on a disc."

Closer interaction among artists could lead to more interesting multimedia creations. Sheckley believes. "With this project we didn't actually do anything together. I wasn't around when anybody else did his part. The story didn't emerge out of a group interaction, which is something I would have been interested in. I would like to do some artistic collaborations because I see creating something as a joint effort almost like an inspired form of play." He flashes a childlike smile. "And I do like to play."

He's also interested in using music as an integral part of a story. "Eno and I had the idea of doing a radio series. We wanted to see whether we could make certain musical things work as story elements."

Should Ipazia, goddess of chance acquaintance, send intriguing collaborative prospects Robert Sheckley's way, it's apparent that he could be tempted to engage in multimedia involvements again. As for his debut, however, his review is unmistakably cool. "Maybe it's art," the modest author shrugs, "but it's not worth a hundred bucks." ∞

TESTING THEIR METAL

STARS

By Mark R. Chartrand II

We've thought for some time now that we understood the creation of the elements. The scenario runs like this. Once upon a time there was a big bang. Matter, time, and space appeared and were flung outward creating the universe. In the primeval pressure cooker, a few of the simplest atoms were concocted: hydrogen, helium, and deuterium. Virtually none of the other elements were formed.

Eventually some of the vast clouds of gas began to feel the gravitational tug of their constituent atoms. The clouds contracted, and the galaxies formed.

Some clouds became spiral galaxies, flat disks with huge central bulges — the galactic nuclei. As these galaxies formed, some denser parts of the clouds split off, contracted on their own, and became the first clusters of stars. These are the globular clusters: huge, almost spherical arrays of hundreds of thousands of stars.

These first globular clusters thus preserve an unaltered record of the composition of the original universe. Later, so the story goes, other globular clusters formed near the center of the galaxies, their stars incorporating some of the gas from earlier stars.

That, at least, is the astronomers' current party line. It may be due for some radical revisions, according to Drs. Catherine Pilachowski, Ronald Canterna, and George Wallerstein of the University of Washington, at Seattle. They arrived at this conclusion after carefully examining stars in 47 Tucanae, one of the brightest globular clusters. 47 Tucanae is located about 16,000 light-years from us in the direction of the Toucan, an obscure southern constellation. This puts it near the galactic center, where we have believed globular clusters are relatively young. Yet Dr. Pilachowski and her colleagues concluded that this is not a latter-day cluster at all, not one that formed from the gases of earlier stars.

The finding hinges on the formation of heavy elements during the evolution of stars. Most stars produce energy by converting hydrogen into helium, then burn out after some billions of years. A few are so massive that they go on to convert helium into carbon, still fewer convert carbon into heavier elements up to iron in the chemist's table. A tiny minority of extremely massive stars end their lives in the inconceivable explosions of supernovas.

These cataclysmic bursts are vitally important to the evolution of the galaxy. The chemical elements are produced within these stars during their normal lives, and still-heavier elements up through uranium appear in the explosion. They fly outward with the blast wave and enrich the surrounding gas. The blast may even trigger the formation of other stars. The next-generation stars are thus enriched in the heavy elements, metals.

What Pilachowski and her associates found was that the stars of 47 Tucanae were less rich in metals than previously thought. So the old assumption that they must have been formed later in the Milky Way's evolution is questionable.

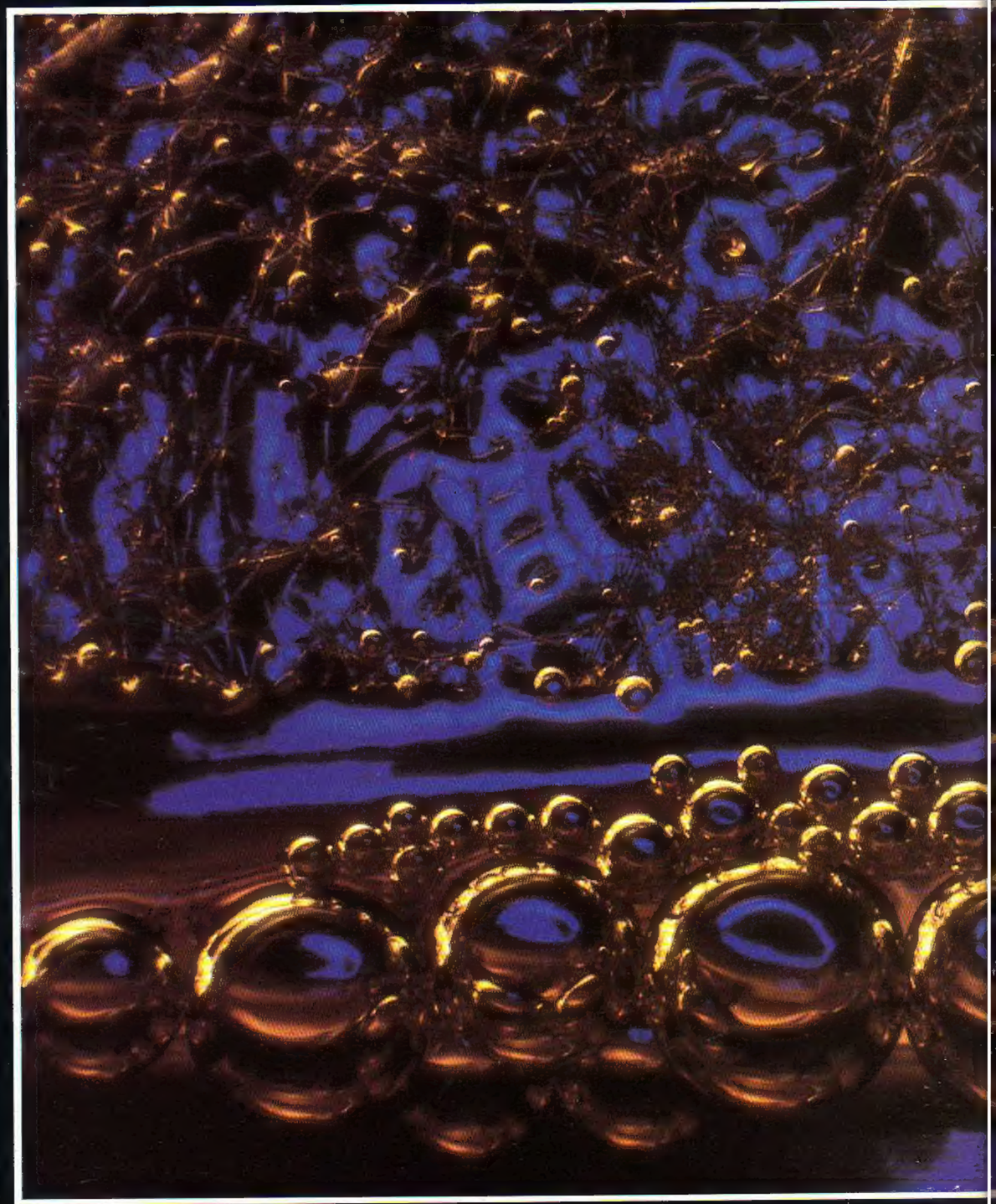
The astronomers looked at single stars in the cluster, instead of examining the light of all the stars combined. Pilachowski, who is now at the Kitt Peak National Observatory, in Arizona, spread the light of several stars into their spectra. Dark lines crossing the spectrum are clues to the abundance of metals in the star's outer layers.

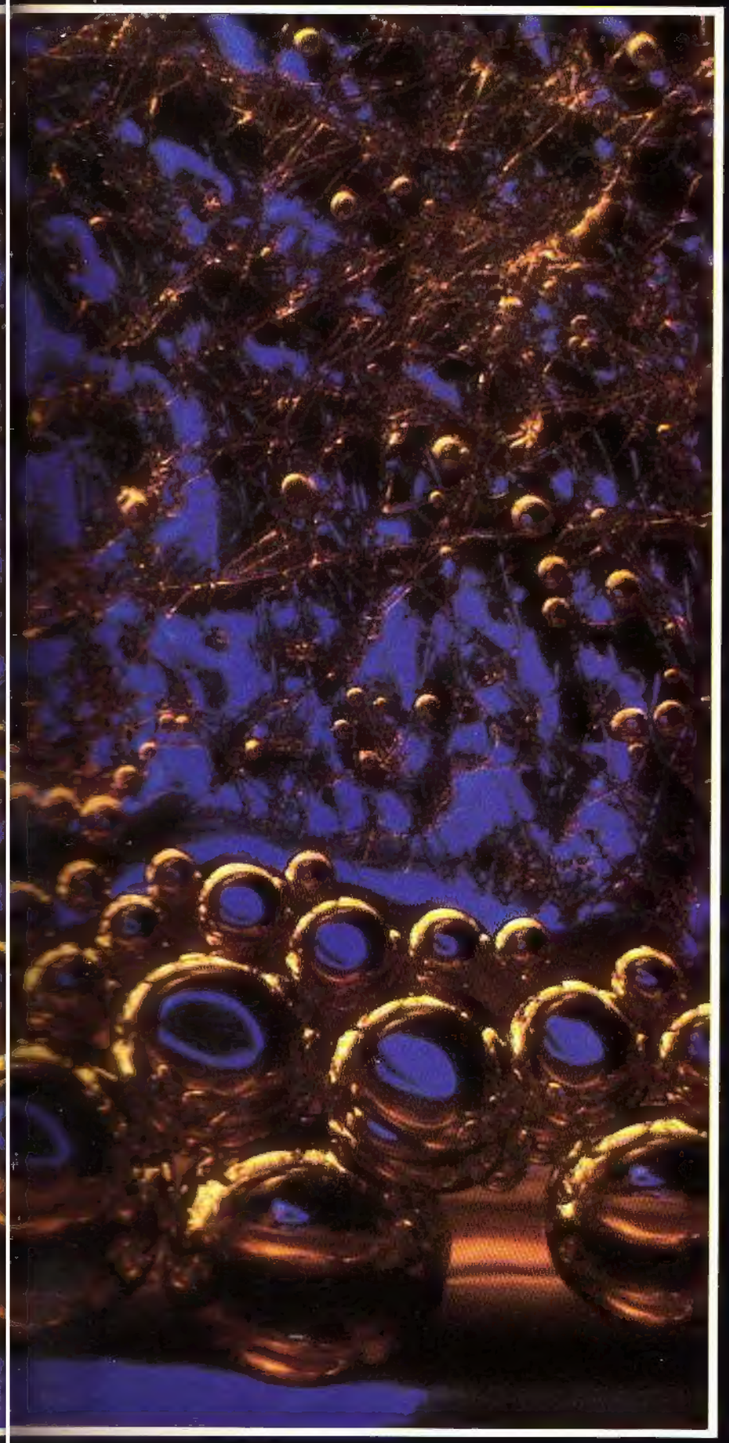
Dr. Canterna, now at the University of Wyoming, at Laramie, studied the individual stars through colored filters which isolated not single spectral lines, but broader regions of each star's spectrum. Metal atoms in the star preferentially absorb light in the blue and ultraviolet regions. Comparisons of the light coming through each filter indicate the number of metal atoms. Canterna's work confirmed Pilachowski's more detailed and difficult study.

If these finds are upheld, it will mean that astrophysicists must go back to revise their idea of when globular clusters formed, particularly those near the galactic nucleus.

As Dr. Wallerstein sums up, "It is becoming apparent that you have to analyze each globular cluster in much greater detail if you want to get it right." ∞

Light from globular clusters shows too little metal. Could they be younger than we thought?





PHENOMENA

GRAND PRIZE WINNER: Simple, brilliant soap bubbles etched on film display clues to the ingredients of an alluring natural phenomenon. This winning photograph in the *Omni* Phenomena Photo Contest was selected because it best illustrates the properties of thin-film pneumatic structures, forms primarily stabilized by differences in pressure. Soap bubbles are "minimum structures," containing the greatest possible volume in the smallest surface area. Ints Plampe created this playful juxtaposition of spheres in a blue universe by dropping soap bubbles into a water-filled aquarium. The background light source is ultraviolet; the foreground illumination was produced with incandescent floodlamps. Plampe photographed his subject with a 50mm 1.8 Canon lens, bellows, and A-1 body. Kodachrome film was exposed at the minimum aperture of *f*/22 for one thirtieth of a second. For the accomplished efforts apparent in this photograph, *Omni* awarded Plampe a trip to Jamaica and a 35mm SLR camera to capture Caribbean phenomena.∞

Who can solve the questions that have stood for a century?

GAMES

By Scot Morris

"God sets us nothing but riddles. Here the boundaries meet and all contradictions exist side by side."
—Dostoevski, *The Brothers Karamazov*

Bishop Samuel Wilberforce is remembered for his questions. Because of his slippery debating tactics and overly facile eloquence, he was given the deprecatory nickname Soapy Sam by his contemporaries. He slipped over his own argument on one occasion, familiar to nearly every biology student. It was at the Oxford meeting of the British Association for the Advancement of Science, in June 1860, just seven months after the publication of Charles Darwin's *Origin of Species*. Wilberforce, staunch defender of the conservative Anglican position, took on Thomas Huxley, the eloquent spokesman for the new theory of evolution. Near the end of a half-hour speech Soapy Sam asked Huxley, "Do you trace your ancestry back to the apes on your father's side or your mother's side?"

Huxley's famous reply, reprinted in countless biology texts, was that, given the choice to have, as an ancestor, either an ape or a man who twisted the facts and hid behind empty rhetoric, he would much prefer the ape.

Not much else is remembered of that great debate or of the bishop of Oxford. Samuel Wilberforce became a paradigm for blind opposition to progress, an easy villain in the triumph of science over obscurantism. But Wilberforce was no villain and no fool, and it is unfair to remember him for this one small incident. For one thing, his writings show that he fully understood what *Origin* was about; he accepted Darwin's law of natural selection as "clear and indisputable"; he even pointed out discrepancies in evolutionary theory that are recognized by biologists today. Darwin himself said that Wilberforce's critical essay on *Origin* was "uncommonly clever: it picks out with skill all the most conjectural parts, and brings forward well the difficulties."

We have recently learned that Soapy Sam was also a skilled gamesman and puzzler. Acting on a tip from Harvard anthropologist Irven DeVore that some of Wilberforce's rhyming riddles still have no known solutions, we contacted Richard Wrangham, biologist and research fellow at King's College, Cambridge, England, who has made a study of Wilberforce's works. (Wrangham is a distant relative of the bishop and in true biological form claims to have "three percent identical genes with him by descent, assuming paternal certainty.")

Caricature of Bishop Samuel Wilberforce, by Carlo Pellegrini ("Ape").

It's true, Wrangham wrote us, Bishop Wilberforce did create a collection of riddles, some of which have never been solved. Knowing how *Omni* readers love challenges and scoff at unsolved problems, we offered the services of this column and the ingenuity of our readers to crack the century-old conundrums.

To get an idea of the kinds of riddles fashionable in Wilberforce's day, here are a few riddles with known solutions. The first was composed by Bishop Wilberforce and circulated by hand until it was printed in *The Marvellous House*, by H. C. Linstead (1879). The solution, also in verse, follows.

THE BISHOP'S ENIGMA

Your boasted invention and wonderful skill
Can almost accomplish whatever you will;
But all your achievements, though splendid they be,
Quite fail to construct a machine such as me.
Examine me well. I've a *box* to enclose
My choicest possessions; but if you suppose
Two lids that I have must be fastened to this,
I tell you at once you are judging amiss.
Two halls of devotion I gratefully own,
Both polished like marble, but built not of stone.
I've *two playful animals*, but the amount
Of my *lesser ones* never I venture to count.
Two fishes that pass through the depths of the sea
Depart not by evening or morning from me.
And others, though varied, yet *fishes* no less,
In greater abundance I always possess.
I've always *two scholars*, twin brothers they are,
And each is as bright and as fair as a star.
You'll think I must live in magnificent state,—
I've *ten Spanish nobles* upon me to wait;
While *two foreign trees* that are verdant and high
Are constantly ready my wants to supply.
I've *weathercocks* countless; and always with me
Are *implements* many, that all men may see
In the carpenter's bag. If you stood at the close
Of a stormy debate, when the Speaker arose
To make his division, 'tis perfectly clear,
Two features of mine you would certainly hear.
Say what is my *Whole*, and be sure in your answer
Each separate part to unfold if you can, Sir.

Have you solved the riddle? Study the italicized elements, then examine the bishop's rhymed solution:

The wonderful structure, when rightly conveyed,
So fair in itself, and so fearfully made,
If truly your famous Enigma I scan,
Ingenious propounder, is certainly *Man*.
How vainly all finite invention would strive
A frame with such exquisite parts to contrive!
The box like a cabinet quickly is guessed,
I'm perfectly sure it is only the chest;
The lungs and the heart, more essential than brain,
This wonderful casket is known to contain.
Two lids we should certainly see with surprise
On the chest; but we know there are *lids* on the eyes.
For the halls of devotion I paused, till I said,
Exactly! *the temples*; I've two on my head.
And the two playful animals; what can be these
But the *calves*? (I mean those of the legs if you please.)
And the lesser ones, those that are countless, you say,
Must be *hairs*, whether sandy or black, brown or grey.
Two scholars, when stripped of their transient disguise,
Are found to be *pupils*; yes, those of the eyes.
I sought for the fishes, and easily found

There were two in the *soles* of my feet on the ground.
Besides these I saw that the shell-fish express
The *muscles* we all in abundance possess.
And then, as to waiters, those Spanish grandees,
There can be no question the *ten-dons* are these.
The trees that for service so gracefully stand
Are both of them *palms*: I have one on each hand.
The weathercocks all as they move in their place,
In the *veins* that run through me I clearly can trace.
He who looks in the carpenter's bag never fails
To find, of all sizes and quantities, *nails*;
And what, when debates are appointed to close,
Says the Speaker, but sharply, "The *Ayes* and
the *Noes*"?

Here are some more *solved* riddles, to clarify the form and help you understand the patterns involved. The first, often attributed to Lord Byron, but actually written by Catherine Fanshawe, was one of Wilberforce's favorites and was written out in his Literary Papers.

1. 'Twas whispered in Heaven, 'twas muttered in Hell,
And Echo caught faintly the sound as it fell. . . .
'Tis seen in the lightning, 'tis seen in the thunder,
'Twill be seen in the spheres when they're driven
asunder.
In the chest of the miser 'tis hoarded with care,
But 'tis sure to be lost in the prodigal heir.
In shade let it rest like a tropical flower,
Ah! breathe on it softly, it dies in an hour.

2. A word there is of plural number
Foe to ease and tranquil slumber;
Any other word you take
And add an *s* will plural make.
But if you add an *s* to this,
So strange the metamorphosis;
Plural is plural now no more,
And sweet what bitter was before.
—George Canning, who served for a short
time as prime minister of England

3. Before my birth I had a name,
But soon as born I chang'd the same;
And when I'm laid within the tomb,
I shall my father's name assume.
I changed my name three days together
Yet live but one in any weather.
—Horace Walpole, English politician and
fourth Earl of Orford

4. My first wears my second; my third might be
What my first would acquire if he went to sea.
Put together my one, two, three
And the belle of New York is the girl for me.
—Hubert Phillips

5. No hard decode. And, in this case,
A solid answer you can claim.
It has (I'm told) a different face
For every letter of its name.
—Hubert Phillips

6. It occurs once in every minute, twice
in every moment, and yet never in one hundred
thousand years. What is it?

7. My first is company,
My second shuns company,
My third assembles company,
My whole amuses company.

Here are two charades with the same answer. Their authors had markedly different views of the subject:

8. My second is doomed to suffer my first,
But of all that he suffers my whole is the worst.

9. With a taste of my first my second is cursed;
But of all my whole suffers, my second's the worst.

Answers: page 138.

THE UNSOLVED ENIGMAS

Now that you have tasted the deviousness of the riddle makers, try your hand at these four riddles written by Bishop Wilberforce. They are all well over a century old and have no known solutions. Study them carefully; then send us your ideas. *Omni* will pay $50 for the best solution to each.

RIDDLE #1
I'm the loudest of voices in orchestra heard
But yet in an orchestra never was seen;
I'm a bird of gay plumage, but less like a bird
Nothing in Nature ever has been.
Touching earth I expire, in water I die,
In earth I lose breath. I can swim, I can fly.
Darkness destroys me and light is my death;
I can't keep alive without stopping my breath.
If my name can't be guessed by a boy or a man,
By a girl or a woman it certainly can.

RIDDLE #2
Man cannot live without my first;
Both day and night 'tis used.
My second is a thing accursed,
Both day and night abused.
My whole is never seen by day
And never heard at night.
'Tis most desired when far away
And hated when in sight.

RIDDLE #3
Not newly formed, yet made to-day,
And most in use while others sleep;
What few would wish to give away
And none would wish to keep.

RIDDLE #4
I'm just two and two. I am hot, I am cold,
I'm the parent of numbers that cannot be told.
I am lawful, unlawful, a duty, a fault,
And often sold dear, good for nothing when bought,
An extraordinary boon—a matter of course—
And yielded with pleasure when taken by force.

HOW TO ENTER: You may send in one solution for each riddle—a maximum of four entries. Postcards are preferred; if you wish to send four solutions at once, write each on a separate card with your name and address on each, and identify the riddle you are solving by its number. Send your entries, postmarked by January 15, 1981, to SOAPY SAM'S SOLUTIONS, *Omni*, 909 Third Avenue, New York, NY 10022.

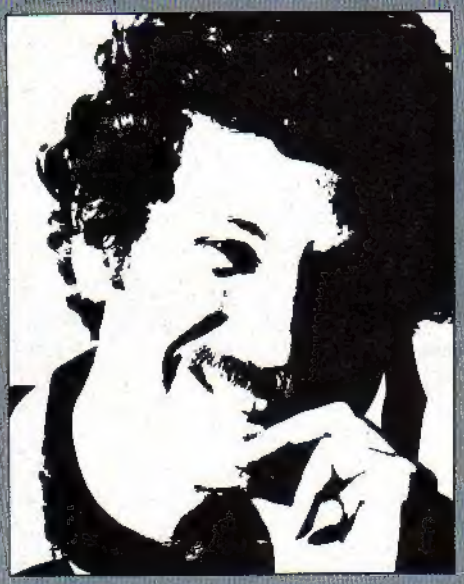
We will sort entries into four groups—one for each riddle. After the deadline, we will select what we consider to be the most likely solutions to each riddle and submit them to a panel of puzzle experts, including Willard R. Espy, author of *Words at Play* and *O Thou Improper, Thou Uncommon Noun*; Ross Eckler, editor of *Wordways* magazine; and Will Shortz, puzzle editor of *Games* magazine. Together we will decide on the best solutions, if any. If "best solutions" are duplicated, the winner will be chosen at random. Good luck!

CORRECTION

In the Dog's Mead puzzle (October) the statement "The current year is 1939" is incorrect; ignore it. It is not necessary to know the current year in order to solve the puzzle. Sorry.

COMPETITION #18: RIDDLES

It's time to update the oldest form of puzzle, the riddle. Compose a new riddle with an *Omni* flavor along the lines of the examples at left and send to: *Omni* Competition #18, 909 Third Avenue, New York, NY 10022. Postmark deadline: January 15, 1981. All entries become the property of *Omni* and will not be returned. Postcards are preferred, please, with one riddle (and solution!) per card. The first-prize winner will receive $100; runners-up (2–10) will each receive $25. Because of space limitations, shorter entries are preferred ∞



LAST WORD

By Eric Lander

"The great sport of killing dinosaurs is by no means dead. Instead, it has become a parlor game of immense popularity: The Extinction Stakes."

Two days before Christmas in 1919, Captain Leicester Stevens boarded the Southampton train at London's Waterloo Station en route to the most daring African safari of his life. His goal: a prize of £1 million sterling to the first hunter who should bag a brontosaurus.

Much chagrined, Stevens eventually returned from Africa without so much as a tiny pterodactyl to show for his efforts. Later adventurers fared no better. By now, when satellites encircle the earth, taking snapshots of auto license plates in Red Square, hopes have all but withered that a renegade pack of tyrannosauruses has somehow eluded the notice of both man and evolution.

Despite this problem, the great sport of killing dinosaurs is by no means dead. Instead, it has become a parlor game of immense popularity:

The Extinction Stakes: Players compete to explain the greatest conundrum in the history of life: how the myriad species of dinosaurs that romped the Mesozoic swamps disappeared without a trace just before the dawn of the Cenozoic Era. Contestants devise elaborate mechanisms to exterminate all dinosaurs, including plesiosaurs, ichthyosaurs, and pterosaurs, but must let reptiles and mammals escape unscathed. Any number can play.

The latest entry, proposed just this year, is the "Single Meteor Theory"—that the murders were the work of a single meteor acting alone—and it comes from Nobel physicist Luis Alvarez and his colleagues at Berkeley. Studying late-Mesozoic limestone strata in Italy and Denmark, the team noticed a thin layer of clay enriched with iridium—a metal much more common in space than on Earth. They postulated that a huge meteor careened into the earth, raising enough dust to blot out the sun for many years. Photosynthesis came to a halt, and dinosaurs, being at the top of the food chain, starved to death. When the dust settled, dormant plants revived and life struck out on a new course.

While not without its charm, the Single Meteor Theory is hardly my favorite. I'm something of a connoisseur of extinction theories and have accumulated upwards of 100, ranging from sunspots to poisoning to paleoweltschmerz.

Until recently the terrible lizards have received very bad press, and it has been assumed that the blame for their demise was not in their stars but in themselves. When scientists disinterred the remains of some 29 iguanodons in a single ravine in Belgium in 1878, they speculated that extinction was the result of mass suicide—psychotic saurians plunging from cliffs like forty-ton lemmings. Contemporary clergymen clung to the belief that, as punishment for some prehistoric sin, dinosaurs were denied passage on Noah's Ark. (Why the Flood would have fazed their swimming relatives remains an unanswered question.)

Mammal chauvinists have long promoted the view that dinosaurs were overgrown, lumbering, and moronic; when times changed, they were too dumb to respond. In the past few years, however, biologists have realized that brain size is not meant to grow in proportion to brawn; in fact, extrapolations show that, if anything, *Tyrannosaurus* and *Coelurosaurus* had a lot more smarts than one would expect lizards of their size to have.

More recent extinction hypotheses implicate environmental factors. Some also belie man's anxiety about his own fate. A sampler:

Constipation: As modern flowering plants replaced oily, laxative ferns, herbivorous dinosaurs died an excruciating death. Other dietary theories cite alkaloids or toxins in the flora.

Poor planning: Unaware of sound ecological management, overzealous carnivorous lizards exterminated their plant-eating prey and then starved.

Eggs in three baskets: Eggs became too thick to hatch, one school says. "Heresy!" shout thin-egg exponents, who trundle out fragments of calcium-deficient shells. One Russian thin-eggian also offers spindly, deformed skeletons as proof of mineral malnourishment, but so far this condition seems to occur only in Soviet fossils. Still a third school maintains that a cadre of small mammals took over the world by eating the eggs.

Aerosol sprays: Radiation came streaming in as the Mesozoic world lost its protective ozone shield. Why? Some adherents of this theory blame a combination of sunspots and the collapse of the Van Allen belts that occurred when the magnetic poles reversed. Others favor a nearby supernova.

Hot and cold flashes: The immense Mesozoic oceans moderated climate. When, at the end of the era, the Rocky Mountains were upthrust and the two supercontinents were fractured, sea level fell, producing the more variable seasons that we know today. While the change was surely crucial, scientists part company over whether the saurians subsequently froze to death in January, fried in July, or succumbed to some combination of hot and cold.

Close encounters: The Doomsday Chronicle also includes: dinosaur wars (a Hollywood favorite); parasites; high oxygen concentration in the air; low oxygen concentration in the air; and, according to one writer, close encounters with little green hunters from Mars.

Sadly, despite some excellent research, we know more about the opening seconds of the universe than about the swan song of the allosaurus. Extinction of course is no shame. The dinosaurs' 120-million-year reign is 40 times as long as man-apes have managed. Still, before some fitter race dislodges us, we might leave notes indicative of where we went. ∞